FACULTY OF ENGINEERING AND ARCHITECTURE

DEPARTMENT OF ARCHITECTURE

THE INFLUENCES OF MODERNITY ON THE ARCHITECTURAL FEATURES OF LIBYAN DESERT HOUSE CASE STUDY-GHADAMES CITY

A Thesis Submitted to the
Graduate School of Science

Submitted by

HAMZA MOHAMED ABUBAKER ALKHAZMI

in partial fulfillment of the requirements for the degree of
Doctor of Philosophy of Science

January 2018

Program: Architecture

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ON
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HAMZA MOHAMED ABUBAKER ALKHAZMI
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Doctor of Philosophy of Science

Approved by:

Prof. Dr. Nur Esin
Chair (Supervisor)

Prof. Dr. Harun Batırbaygil

Assoc.Prof.Dr. Ebru Erdönmez

Prof. Dr. Demet Irklı Eryıldız

Prof. Dr. Gülçin Pulat Gökmen

January 2018
Program: Architecture

I hereby declare that all information in this thesis has been obtained and presented in accordance with academic rules and conduct.

Hamza Mohamed Alkhazmi

SUMMARY

THE INFLUENCES OF MODERNISM

ON

THE ARCHITECTURAL FEATURES OF LIBYAN DESERT HOUS

CAS STUDY-GHADAMES CITY

This study investigates the architectural features of traditional desert house and the influence of modernity on it in Ghadames city in Libya, where muddy-wooden old houses are built organically to provide high levels of private lifestyle and to protect their dwellers from harsh conditions of desert climate. These houses form about 80% of the old city. After the occupation of mass-production housing projects several features of houses in Ghadames have been influenced.

The study presents a comparison between two samples of traditional houses and contemporary houses in terms of the architectural style, privacy satisfaction of occupants and thermal performance of muddy and concrete houses. Several methodologies were applied on the samples and their users to figure out if there are similarities or differences between samples. These methods are social survey which includes questionnaire and in-depth interviews with users, field survey for collecting climatic data and using Space Syntax UCL DEPTHMAP and AGRAPH for measuring visibility and visual privacy. The extracted results indicate whether traditional houses and contemporary houses are having similar features or not.

The structure of thesis could divided into five chapters. First chapter is covering the theoretical part; chapter two includes the concept of house and modernity, or the house from traditionalism to modernism. Chapter three introduces the architectural features of desert dwellings in Ghadames. The fourth part presents an explanation of indoor privacy and its measurements in the samples. The second phase of the comparison is analyzing the climate responsivity by comparing the thermal performance of all samples.

Shortly, the study attempts to observe qualitative and quantitative results that are extracted from methodologies and considered as indicators that show to what extent transforming from traditionalism to modernism (Modernity) has influenced the continuity of indoor privacy satisfaction and thermal performance within houses of Ghadames oasis.

Keywords: Traditional Houses, Contemporary Houses, Modernism, Privacy, Space Syntax, Thermal Performance.

ÖZET

MODERNİTENİN

LİBYA ÇÖL EVLERİNİNMİMARİ ÖZELLİKLERİ ÜZERİNDEKİ ETKİSİ: GHADAMES ŞEHRİ ÖRNEĞİ

Bu çalışma geleneksel çöl evlerinin mimari özelliklerini araştırarak, Modernizmin Libya'nın Ghadames Şehri üzerinden etkilerini incelemektedir. Ghadames Şehri üst seviyede mahremiyet sağlamak ve çöl ikliminin zorlu etkilerinden en üst düzeyde korumak amaçlı olarak çamur ve ahşap gibi organic inşaat malzemeleri kullanılarak inşa edilmiştir. Bu konutlar eski şehrin % 80 ini oluşturmaktadır.

Konut projelerinin seri üretimle üretilmesi sonrasında Ghadames evlerinin bazı özelliklerinin etkilendiği görülmektedir. Bu çalışma, seçilmiş geleneksel ve çağdaş konut örnekleri üzerinden mimari tarz, mahremiyet gereksinimi konusundaki kullanıcı tatmini ve geleneksel kerpiç konutların ve betonarme evlerin iklimsel performansından memnuniyet açılarından karşılaştırmalı bir incelemesini sunmaktadır. Örnekler üzerindeki benzerlikleri ve farklılıkları ortaya koymak üzere çeşitli metodolojiler uygulanmıştır. Bu metotlar, kullanıcılarla derinlemesine görüşmeleri ve anketleri içeren "sosyal araştırma"; iklimsel performansın ölçüldüğü ve mahremiyetin araştırılması için planların incelendiği "saha tespitleri"; verilerin analiz edildiği "mekan dizimi analiz yöntemi"dir.Mekan dizimi yöntemiyle UCL DEPTHMAP and AGRAPH teknikleriyle görülebilirlik ve görsel mahremiyet ölçülmüştür. Çıkartılan sonuçlar üzerinden geleneksel ve çağdaş konutların benzerlik ve farklılıklarına bakılmıştır.

Bu tez beş bölümden oluşmaktadır: İlk bölüm literatür araştırmasına dayalı kuramsal bölümdür. Konu alanında yapılan diğer araştırmalar incelenmiştir. İkinci bölümde konut kavramı, modernite kavramıyla birlikte ele alınmıştır. Gelenekselden Moderniteye geçiş incelenmiştir. Üçüncü bölümde Ghadames şehri geleneksel konutlarının mimari özellikleri incelenmektedir.Dördüncü bölüm iç mekanda mahremiyet kavramı görsel bakımdan ele alınmakta, ölçümler sunulmaktadır.

Karşılaştırmanın ikinci aşamasında termal performansları ölçülerek geleneksel ve çağdaş konutlarda iklim duyarlılığı bakımından karşılaştırmalar yapılmaktadır.

Özetle, çalışma, çeşitli metodolojilerle elde edilmiş nitel ve nicel sonuçlara dayalı olarak Ghadames şehrinin modernizmin etkisindeki çağdaş konutları ile geleneksel konutları iç mekan mahremiyeti ve iklimsel konfor performansı bakımından karşılaştırılarak, gelecekteki konut tasarımları için çıkarımlar yapılmaktadır. Geleneksel konutların başarılı mimari özelliklerinin geleceğe aktarılması hedeflenmektedir.

Anahtar Sözcükler: Geleneksel Konutlar, Çağdaş Konutlar, Modernizm, Mahremiyet, Termal Konfor, Mekan Dizimi Yöntemi

To my parents

My family

My friends

To the soul of my cousin Abduolqadir AL-Majdoob

To the soul of my aunt Aisha Abubaker

ACKNOWLEDGMENT

First of all I thank God for giving me health and strength. Secondly I would like thank people who directly or indirectly contributed in this work.

I deeply would like to thank my supervisor Prof. Dr. Nur Esin for her guidance, encouragement, and advice through the period of research and for being such helpful and supportive.

Prof. Dr. Harun Batırbaygil for his advice, encouragement and help.

Prof. Dr. Omar Salama Omar. For his help and support.

Engineer. Khaled Mohieddien. Engineer, Othman AL-Hashayeshi and Engineer, Abdussalam AL-Hashayeshi for their assist and support.

Finally., my special thanks for my teacher (Abdussalam Abdulmottalib), my dear friends Abdullah Joumaa, Moftah ahmad Saadullah. AL-hajj AL-Aiesawy Salih.

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SYMBOLS

MD Mean depth of a space or axial line

RA RELATIVE ASYMMETRY OF SPACE OR LINE

RRA REAL RELATIVE ASYMMETRY

k = thermal conductivity of the material (W/m-K)

A = area (m2)

L = thickness (m)

Th = temperature of the hot surface (K)

TC = TEMPERATURE OF THE COLD SURFACE (K)

h= heat transfer coefficient (W/m^2-K)

T_s = temperature of the surface (K)

T_F = TEMPERATURE OF THE FLUID (K)

σ = Stefan-Boltzmann constant (5.67x10-8 W/m2-K4)

A = area of surface (m2)

T1 = temperature of surface 1 (K)

T2 = temperature of surface 2 (K)

$\varepsilon 1$ AND $\varepsilon 2$ = EMISSIVITIES OF SURFACES 1 AND 2 RESPECTIVELY

ε = emissivity of the building exposed surface

Ts = temperature of the building exposed surface (K)

TSKY = SKY TEMPERATURE (K)

ABBREVIATIONS

1. INTRODUCTION

1.1. Introduction

From the beginning of human existence, there has been a struggle between human and nature where the man managed to live harmonically with nature. On one hand, the nature forced its limitations on human activities such as way of life, social interaction, building a shelter and benefiting from local resources; on the other hand, these activities have to be taken into consideration in order to adapt with nature.

The distinction of being survive (remaining alive and safe) has forced humans to create means for clothing, hunting, agriculture and building a shelter to live in and protects them from wild animals as well as climatic conditions. During the whole stages of human history, people have been living successfully in an enormous variety of climatic conditions by developing shelters which have been well-known as houses, homes, dwellings, and residences.

From the ancient ages, people have always tried to take into consideration the local climatic characteristics in designing of the traditional houses (Özay, 2004).The need for house has developed from physical protection to meet psychological, social and cultural needs such as social interaction among individuals, families, and societies in terms of "socio-cultural relationships and privacy", regardless of the place, culture and time.

In an Islamic tradition, especially the visual privacy is a crucial determinant of the quality and social value attached to the dwellings. The gender segregation between males and females of a society is the primary concern that has taken into consideration by employing special types of entrances, windows and spatial organizations. People of Ghadames City ensured to use such techniques to provide high levels of privacy within their houses.

This architectural style did not last, but it was highly influenced by Modernism, which started in 1970s of last Century when Libyan Government started to build new concrete residences that were constructed by different building materials in different designs.

This caused appearance of new houses with different architectural style and less thermal efficiency. It has led to create a gap between traditional houses and contemporary houses in terms of privacy and thermal performance or climatic responsivity.

This study investigates the impact of Modernism as a result of modernity concept / theory on the continuity of privacy values as a socio-cultural requirements and thermal performance of desert house in Ghadames City in Libya. Comparison between samples of both traditional and contemporary dwellings has been made by using some numerical techniques.

Therefore, the study will inquire the common features and differences between modern and old traditional houses in terms of privacy and thermal performance. The reasons that caused differentiation in dwellings properties to benefit from the advantages and to avoid disadvantages have to be searched to be as a base of future design of desert house for increasing the quality of Libyan desert house.

1.2.Research Background:

It is well-known that traditional houses in desert regions were built according to soci-cultural and climatic requirements where they have successfully organized the social relationship between society members and provided protection from harsh climate conditions. In the past, builders of traditional settlement of Ghadames had constructed their dwellings to meet climate conditions as well as socio-cultural needs (Shawesh, 1993). Natural local building materials such as mud, stone and wood were employed to build these residences.

Traditional houses lasted till the beginnings of seventeenths of last century when citizens of Ghadames abandoned their traditional dwellings and moved to the new-modern town which completely built by concrete materials where modern houses are totally different from old homes in terms of design and building materials which has led to create a gap between traditional and contemporary houses.

Several scholars and architects such as Fathi advised architects and designers to renew traditional architecture from the moment when it was abandoned and try to bridge the existing gap in its development by analyzing the element of change and applying modern techniques (Fathi, 1986). Some other researcher discussed the problem of Modernity and Continuity in Architecture (Yıldırım, B., 2017). It is discussed as if we can find ways to resolve the disconnection between contemporary requirements and the continuity of the past in architecture.

This research also looks for such inappropriateness between tradition and contemporary in Modernity means. Study will attempt to create a comparison between traditional houses and contemporary units to figure out how extent modernism has influenced the continuity of the architectural features of traditional houses.

1.3.Problem Statement

Rapoport (1981:21) mentioned that: "*Housing is essential, it is a basic human need and central component in our daily lives. For most groups in our culture the dwelling is very central.. ...most time is spent in it; it is one's most valuable possession. It has highest effective meaning and it is increasingly the locus of much recreation previously occurring elsewhere*".

The importance of dwelling comes from the human beings need for protection, stability, privacy, comfort, security and region. If shelter failed to provide these, the comfort, health, and morale of the users can be seriously affected. The ways in which occupants behave in their environment is a reflection of their "ego". The design of a dwelling reflects certain beliefs and attitudes. "*Standing in the community is a self-evident from one's home, and mirrors the history of the occupant and his cultural values with society*"(El Fortea, 1989).

In hot arid regions in Arab-Muslim counties, climate and privacy values are the most important factors which affect directly a house design.

The old builders of traditional settlement of Ghadames city in western region in Libya, had taken into consideration these factors where they built their own dwellings to occupy them in a harmonious and safe atmosphere. The attached houses with thick walls and roofs (thick envelope), and shaded streets are techniques used to reduce the impact of sun radiation in the summer and cold air currents in the winter. In terms of privacy, traditional houses of Ghadames were built to be mainly in three floors where gender segregation is obvious.

Residents of Ghadames had kept the architectural style of their traditional houses till the beginnings of seventeenths of last century when modern concrete houses were built to form the modern part of the city. People of Ghadames had fascinated by these modern houses and moved to live in a modern lifestyle where electricity, water supply network and sewage network to be found.

"*The state has endeavors to provide an convenientdwelling for each family in terms of quality, size, design and standard, taking into consideration the potential and changes of the social, cultural and economic conditions, as well as customs and traditions and hence their expected impact on the design and forming of the dwellings.*" (El-Fortea, 1989).

With the passage of time, the government had made contracts with foreign companies such as POLSERVICE, DOXIADIAS and Turkish construction companies. The large number of plans and designs of modern houses were planned according to "The International Style" which scattered in North Africa after World War II and built by new building materials such as cement, concrete, and steel. According to previous studies this type of building do not take into account the provision of comfort, privacy, and the architectural characteristics of traditional house which had led to create a huge gap between traditional and contemporary houses in terms of thermal comfort and privacy.

A large percentage of Libyan citizens in contemporary houses are depending on alternative techniques to provide privacy such as using separated urban fabric and surrounding the houses by high external walls or closing terraces which has affected the architectural form of houses. For thermal comfort, the modern concrete houses have caused increasing in consumption of electricity because of using electrical and mechanical means to improve the thermal performance and providing thermal comfort in summer and winter.

1.4.Research Hypothesis

Hypothesis is one of the most important elements in constructing researches. Bailey (1978), defined hypothesis as a suggestion in testable form and predicts a specific relationship between two or more variables, while Grinnell (1988) mentioned that hypothesis is formed in such a way that it can be proven or disproven by reliable and valid data.

Hypothesis should be clear and direct to provide clarity and help to narrow down the scope of research. According to the mentioned above, hypothesis of the study could be formulated as follows:-

- Traditional dwellings in Ghadames were built to provide high levels of visual privacy and with better climate responsivity (thermal performance).
- Transformation from old buildings to modernity affected house design and city planning.
- The new modern desert houses do not satisfy privacy and climate responsivity.

1.5. Research Question

To figure out the architectural features of both old and modern houses in terms of the appropriateness of life style, privacy and thermal performance, and to understand how modernism influenced these features, the study should answer the following questions:-

a. What are the architectural features of traditional houses?

b. Are privacy provision and thermal comfort are important factors in desert house design?
c. To what extent modernity affects Libyan desert house and what are the aspects of change?

These questions are answered during the course of the research, and a complete image is given of the suitability of the two types of housing, traditional and contemporary, throughout the perception of the people who occupy them.

1.6.Methodology

In order to achieve the aims of the study, a comparative approach will be applied on both old-muddy and modern-concrete houses by choosing samples from each type. The study collected the required data which form a concrete evidence of the architectural features of Libyan Desert House.

This data was collected from documentary sources and field work by employing the following methods:-

1- Theoretical study is conducted based on books, scientific journals, governmental reports, manuals and toolbooks, thesis and websites. These literatures are the main sources of the explanations of the socio-cultural values of Ghadames society, beside the architectural features of traditional and contemporary houses, and modernity in architecture.

2- Empirical studies were employed to investigate both traditional and contemporary houses in terms of privacy and thermal performance satisfaction of the two types. To measure the degree of user satisfaction of privacy the study employs softwares such as UCL DEPTHMAP and AGRAPH that are used to measure the spatial organization and visual privacy of houses design. For measuring the thermal performance and thermal comfort in houses research requires using a digital thermometer instrument to measure indoor and outdoor temperature in a specific times.

3- Social survey of Ghadames people's perception which is consists of two parts:

a. An in-depth interview survey: In this section data will be collected by means of personal interviews and open informal discussions with some residents and several key figures from the city of Ghadames and the Ministry of Housing.
b. Questionnaire: Three types of questionnaires are used: First a users' satisfaction questionnaire with daily social lifestyle. Second, people's satisfaction with privacy and visual privacy. Third, questions are about the thermal performance of dwellings.

1.5. Research Objectives

The objectives of this study are chosen to emphasize the concept of occurring a gap between traditional and contemporary desert houses in Ghadames city. The objectives of this study have been formulated as follows:-(see Figure 1.1).

1. To identify the architectural characteristics of traditional dwelling in Ghadames settlement.
2. To evaluate to what extent modern houses are different from traditional houses.
3. To examine the perception of inhabitants towards the continuity of architectural features from traditionalism to modernism.

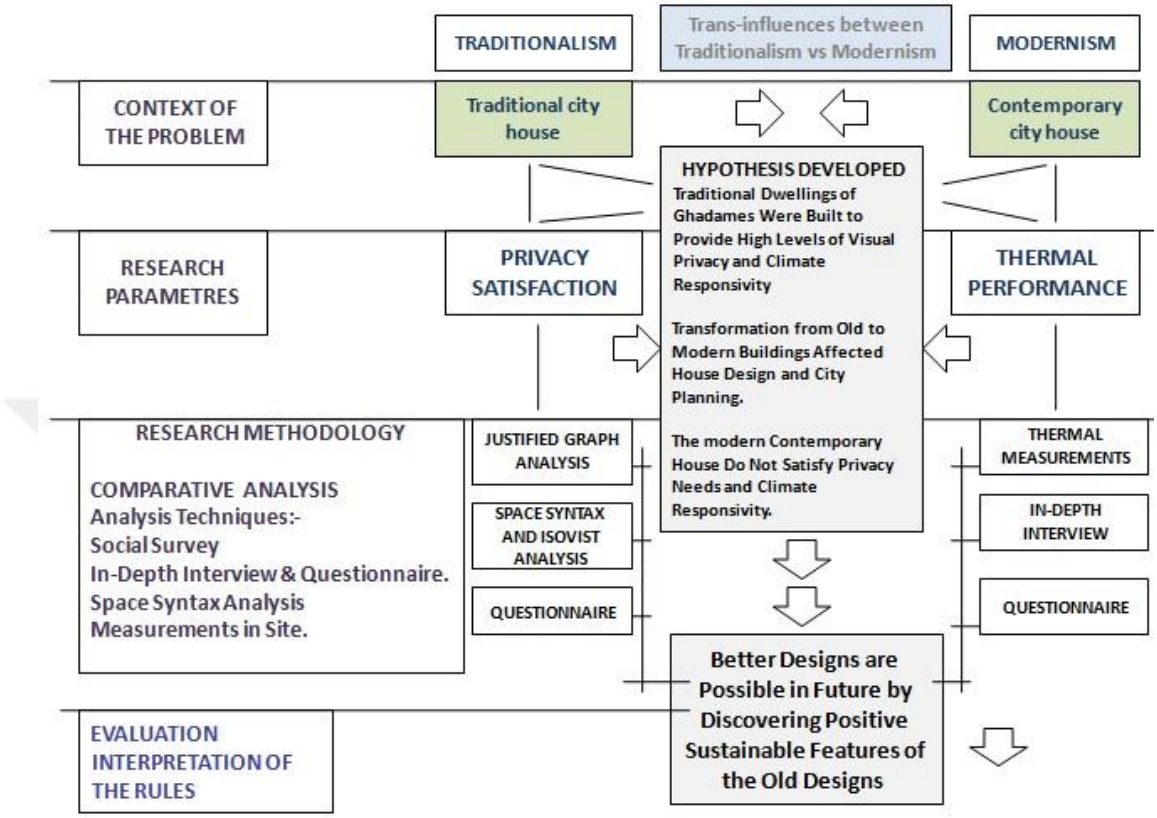


Figure (1.1) Research Process Plan (source: author).

2. HOUSE FROM TRADITIONALISM TO MODERNISM

2.1. Definition of House

The origins of word House in English language is extracted from the word "Hus" which means house, home, dwelling, and shelter (online etymology dictionary, 2012). House as a term has been defined by several scholars, for Schoenauer and Norbert (2000) a house is a building that functions as a home, ranging from simple dwellings such as primitive huts of nomadic tribes and random shelters in shanty-towns to complex, fixed structures of wood, brick, concrete or other materials which contains plumbing, ventilation and electrical systems.

The house as a concept has been studied in different scientific areas, as an ecological approach, house is a relationship between individuals and environment, where Henny Coolen (2005) pointed that The concept of house concentrates on the purpose of interactions of family and society, The mutual interactions between people and the environment and how the people utilize the nature. these are the key factors in ecological approach, therefore, it could be found in various stages of arrangements and considered as a basic need for a mankind in the nature which itself avails many services like providing awning, safety, confidentiality, stability and control (Coolen, 2006).

For Douglas(2000), home was defined as a residence place for intimate, where inhabitants organize their resources, in-between relationships and ceremonial costumes. A dwelling is another term that has been used as a synonymous with house. Rapoport explained that dwelling is as the sub-system of group of settings, included in the bigger system of settings called the environment, in which certain systems of activities take place (Rapoport, 1990).The words house, dwelling and home are words linguistically mean a place for protection, living, sleeping, resting and intimacy.

Houses utilize a series of different roofing systems to prevent rain and other precipitation from entering the living space. Houses may have doors or locks to ensure the safety of living area and to protect residents and contents from thieves or other intruders. Most traditional and modern homes in Western culture will contain one or more bedrooms and bathrooms, a kitchen or cooking area, and a living room. The house may have an independent restaurant, or the living area may be related to another room. Some big North American residences have a playroom. In traditional agriculture-oriented societies, domestic animals such as chickens may share part of the house with humans. The social units that live at home are called families.

2.2. Historical Development of the House

Throughout history and according to archeological studies, the primitive man is used to live in caves and wholes to live in, where he used them as a shelter to protect himself from wild animals and climate factors. Later, the man had created simple devices to hunt, cut and form wood and stone to use them as building materials, then he replaced randomly-built houses with well-built and organized houses that were in different design (space organization) and form (elevation and mass). This type is called traditional, vernacular, and folk houses (Rapoport 1969).

After the appearance of the cement, concrete and steel as new construction materials the construction process has changed in the amount, design, and the form, where mass production occurred and became the most widespread in the globe especially in Europe and North America. According to what mentioned above, there are two types of houses could be classified in terms of modernization into:-

a. Traditional or vernacular houses.
b. Modern or contemporary houses.

2.3. Traditional Houses

The term "traditional" is derived from "tradition" which in turn comes from the Latin word "traditio" and the word "traderere" which means (to transmit or to give for or to hand over). This term had been used to refer to legal transfers or inheritance in ancient Roman low (Giddens,2003).During the last two centuries, especially during the enlightment period, thinkers, writers, and philosophers had evolved and used the term of tradition to be a contrary of modern (Giddens, 2003). However, a tradition as a concept has been defined by several scholars, Green, 1997, pointed that tradition is a belief, customs, or action transferred within a group or people with a symbolic meaning or special significance with origins in the past . this concept is also found in philosophical, political, anthropological, art, and architectural fields, which is referred to an old philosophy, or old man and his tools, old drawings and paintings, and old buildings. The concept includes a number of linked thoughts; the common one is that tradition is referred to beliefs, objects or customs performed or believed in the past, produced in it, transformed through the time by one generation to the next, and are performed or believed in the present (Green, 1997) .

The term of vernacular is extracted from the word "*vernaculus*" which is Latin word and it means "*native, domestic, and indigenous*" (Cambridge dictionary).In architecture, vernacular architecture is referred to an architectural style which is indigenous to a specific time or/and place. (Merriam-Webster, 2000).Vernacular architecture is another term used to describe an architectural style which is linked to the traditional architecture. According to Brunksill vernacular buildings are *"buildings designed by an amateur without any training in design; the individual will have been guided by several features which have been built up in his locality, paying little attention to what may be fashionable. The dominant factor of the building would be the function the as well as aesthetic requirements, Local materials would be used as the main building materials.*"

As being defined in encyclopedia of vernacular architecture. Vernacular architecture is "*the dwellings and all other buildings related to their environmental factors and available resources they are customarily built, utilizing traditional technologies. All forms of vernacular architecture are built to meet specific needs, accommodating the*

values, economies and ways of life of the cultures that produce them". (Encyclopedia of Vernacular Architecture of the World).

Vernacular buildings tends to transfer over time to reflect the environmental, cultural, technical, economic and historical context in which it is located. Although it is often difficult to be compatible with the general requirements of the five factors that mentioned above. This architectural style still plays a role in architecture and design.

Unlike the polite architecture, which is characterized by the stylistic elements of design that deliberately combine aesthetic requirements beyond the functional purposes of the building (Giddens, 2003).

Whether it is a traditional or primitive or vernacular architecture, this type of architecture had been built in a specific time and place, and built to meet environmental or climatic conditions, socio-cultural needs, to provide privacy and intimacy for occupants. This type of buildings has been influenced by several factors which played a major role in forming the architecture of these buildings.

2.4. Modifying Factors That Affect Traditional Houses

The architecture and evolution of house have been analyzed by several scholars, one of the most important studies is Amos Rapports', 1969 (House Form and Culture) where he highlighted that, the house is an institution, not just a structure, created for a complex set of purposes; because building a house is a cultural phenomenon its form and special organization are highly affected by cultural environment to which it belongs (Rapoport. 1969).The architecture of traditional houses, according to Rapoport, is influenced by some factors. These are socio-cultural, climatic, construction materials and building technologies.

2.4.1. Socio-Cultural Factors

Traditional houses design and form varies from society to society and from culture to another, for example, traditional Japanese house differentiates from Persian house and Arab-Muslim house differentiates from Roman or Greek house in terms of form and spatial organization within house.

In vernacular Muslim dwellings whether it is in Libya, Egypt, Iraq, or in Tunisia or Turkey, they were built and organized according to cultural and religious roles that are extracted from the teachings of Qur'an and Sunnah.

Socio-cultural factors which influenced the architecture of traditional dwellings have been studied in different fields, Rapoport classified these factors according to the principle of (Genre De Vie) into:-

a- Family.
b- Position of women.
c- Privacy.
d- Social intercourse.

On the macro scale, traditional settlements in Arab-Muslim cities were organized and built to meet socio-cultural needs such as privacy, social relationships and traditions for both individuals, families and society.

2.4.2. Climate Factors

The relationship between man and house goes back to the beginnings of human existence, where he used several strategies to build his primitive house as a shelter which protects himself from wild animals and weather.

According to Rapoport, the house is a container that was built to be a shelter or container and protects its users and contents from animals and human enemies and those natural elements that known as the weather. (Rapoport, 1969).

In hot-dry regions which are featured by high temperatures at daytime and low temperatures at night, primitive builders had used several techniques to avoid undesired heat and to provide protection from harsh conditions of desert climate, these strategies in particular could summarized as follows:-

a- Using high heat capacity materials such as adobe, stone, mud, and/or mixture of these materials.
b- Painting walls by white or light colours to reflect direct sun radiation and then minimizing the gained heat.
c- Windows and doors are located in small areas and placing them at high levels to allow to colder air to fall down.
d- Minimizing surface area that exposed to the external heat via using attached (compact) urban fabric, covered and shaded streets and using multi-floor (vertical) buildings instead of horizontal construction.

Then, the main target of the architecture of dwellings in desert areas is to avoid direct heat or sun radiation and decreasing gained heat and increasing thermal comfort.

2.4.3. Construction Materials and Building Technologies

"*The choice of building materials and their availability and construction techniques in an architectural situation will greatly influence and modify the form of building*". (Rapoport, 1969).Primitive builders used local-natural materials that had been extracted from the local ambient environment, where they were able to cut, refine, and form raw materials whether they are stone, mud, adobe, wood or mixture of these materials. In eastern and southern of Asia (Japan, china, and Malaysia) wood is the main constructing materials in traditional houses while most of the traditional settlements in the Mediterranean sea coasts were built by stone and wood. In desert areas, the primitive builders successfully used the local materials, in the empty quarter desert in Saudi Arabia the hairy and wooden tent were the common dwellings, whereas the muddy stone houses were built in Ghadames-Libya, Matmata-Tunisia and Mardin in Turkey.

Techniques of construction process of desert traditional houses are characterized by the following:-

a- Using natural-local materials.
b- Load and moment forces are transferred from roofs to thick walls to the ground.
c- The roof building materials whether it is stone, wood or wood covered by mud it will not be able provide wide spanning, for this reason the spaces in traditional buildings are small.
d- Urban fabric in hot dry climates were built by narrow non-straight streets and attached buildings to form the compact urban fabric which characterizes the traditional Arab-Muslim cities

2.5.Architectural Features of Traditional Houses

The traditional settlements in Libya are scattered on the north coast, mountainous spots and in few oasis in the Libyan Desert (Sahara). What distinguish these settlements their ability to protect their inhabitants and their architectural style.

Bonu, 1960, highlighted that:- "*The typical modest popular architecture of Libya is identified with spontaneity, genuine simplicity, and an analogy to the indigenous architecture of southern Italy and Spain and other regions of North Africa. An architecture of pure whiteness, brightness, rich in volume with sparse but not ugly decorations, it is in harmony with the landscape and the environment, and responsive to climatic conditions. The adherence to the needs, customs, and life necessities of the population and the consistent and rational use of available materials show a sensitivity which underlines the fundamental aesthetic value of this architecture*".

Traditional architecture is affected by a great various phases of human behavior and environment, leading to differing building forms for almost every different context; even neighboring villages may have artfully different methods of the construction to build their residences, even if they at first appear they are same. Despite these differences, every building is a subject to the same laws of physics, and hence will present significant common features in structural forms. Several studies had been done about the architectural features of traditional houses in desert regions, the following part

represents the most important approaches about these features and the main factors that affected forming of vernacular dwellings**.**

2.5.1. Rapoport Approach

The famous architect Amos Rapoport has studied the architectural properties of traditional house in his outstanding work (House Form and Culture, 1969) where study classified the characteristics of traditional desert house into the following points:-

a. Traditional houses are built by local-natural materials that are derived from the ambient environment.

b. Socio-cultural factors such as privacy, position of women and social intercourse are crucial in forming traditional house layout.

c. Climate is the most important factor in shaping the layout and envelope of traditional desert dwelling.

2.5.2.Shawesh Approach

Abubaker Shawesh is a Libyan scholar who is specialized in housing science, he accomplished an important study about the development of Libyan house design under the title of "Housing Design and Social Values in Libya: An Investigation of Traditional and Contemporary Housing" where he studied the evolution of Libyan house and concluded that:

a. Due to the considerations of privacy Libyan people prefer building single-separated unites instead of owning flats or shared apartments.

b. Traditional houses in Libya were built by local-natural substances and methods.

c. In vernacular dwellings visual privacy, gender segregation and human behaviors are important determinants in spatial organization of old houses layout.

d. Climate is very important determinant in the architecture of desert regions, where it forced builders to use compact texture of folk residences and neighborhoods with covered streets in old Ghadames city. This compact form successfully resisted the hard conditions of hot-dry climate (Figure 2.1.)

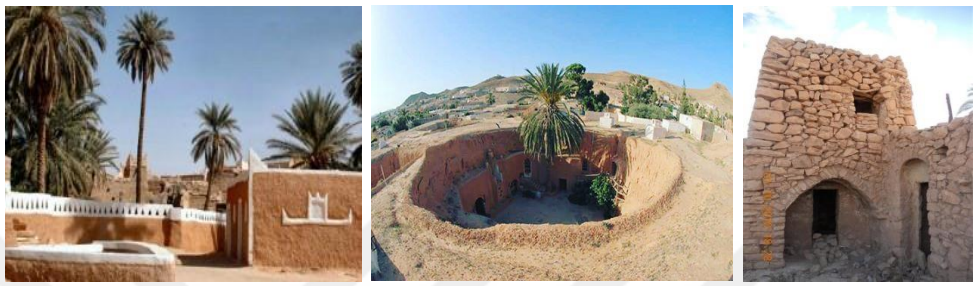


Figure (2.1) Traditional Muddy house in Ghadames city (left), Middle, Holes Houses in Gariyan city (middle), Stone Hoses in Bani Waleed City Libya (right), (source: Author)

e. Modern houses in desert region are built by new different techniques and materials and they are less efficient in terms of the efficiency of thermal performance.

i.Climate Responsivity

In our world, the requirements of occupants and their lifestyle forms the traditional buildings in each district. In a specific zone, design of buildings is effected by several effective conditions such as, geographic features, climate, local materials and cultural factors (Izgi 1999, Rapoport 1980, Eldemery 2000). From an architectural point of view, culture and climate factors have a major influence on the arrangement and links of internal and external spaces.

For Yaldiz, 2009, requirements such as architectural style, material and organization of spaces within a building are all influenced by climatic conditions such as the speed and direction of wind flow and sunlight, amount of precipitation, temperature level, humidity, and air pressure).

Oktay (2001), highlighted that climate affects both vernacular and traditional architectures. During various historical stages, human beings have tried to build their houses as much adapted to climate as possible. Hence, the features of architecture have been always directly linked to the climatic conditions.

The sun radiation (sunlight) is being considered as the main source of heating in hot climate regions. Thus, arranging the orienting the position of the openings and external envelope in the building according to the direction of the sun is very considerable factor. It is also recommended to take into consideration the direction of dominant hot winds in designing buildings. These two issues are important both during the harsh hot season in hot arid zones and in the cold nights in cold climates. A well-oriented building consumes less energy for needed for cooling and heating (Zandi, 2006).

It is well known that the selection of construction materials is linked to the climate condition. In traditional architecture, the choices are limited because it depends on the availability of local resources. Thus in different regions and climates, the selected available materials were adapted to meet climatic conditions of these regions.

Thermal capacity and thermal resistance of the building materials are two main physical properties which they have a great influence on thermal performance of buildings. In different environments, extreme frequent climate conditions are known as critical periods. For example, In hot-dry (desert) climate, daily temperature in summer days reaches about 50^0C while it drops to about 0^0 C therefore, in such places the building materials should be well-adjusted to hot-dry climate during the day in such a way that indoor air is not influenced by the outside high temperature.

In hot-dry climate, temperature ranges a lot between the day and night. Therefore, dense materials should be employed to build the external envelope to protect internal spaces mostly used during the day. Conversely, low heat capacity of light materials are more suitable to build the spaces mostly occupied during the night. In desert climate zones, Stone materials according to their high thermal capacity and resistance are proper (Ghobadian, 2006).

According to heat transfer theory and thermodynamics science, heat always transmits to from hotter to colder spaces. Actually, in desert environments, walls gain heat during the day and then, gradually heat is stored in the body of walls and roofs (house envelope). During the night temperature drops and external air becomes colder, external envelope tends to gain cold, this heat is transmitted into the internal space. Consequently, the inhabitants feel comfort as the interior walls are cool during the day and warm during the night (Zandi, 2006).

There are several important determinants which determine the thermal performance of indoor spaces as well as thermal and energy efficiency of a building. These determinants are design style, size of spaces within buildings, spaces between houses, external envelope design, natural light management, and thermal features of the external parts of building envelope. House envelope separates indoor spaces from external area so, therefore, envelope design is considered as the most important part (Behbood, 2010).

Barnett(1995),mentioned that it is important to study the evolution of sustainable buildings and what our intimates did in order to stay homogeneous with the environment. By ignoring these aspects several sustainable design strategies according to nature and environment will fail to implement.

The relationship between buildings orientation and Solar is one of the most primitive strategies in traditional buildings. Our ancestors learned how to build houses and take the solar energy of sunlight in cold months and to minimize its heat during the hot seasons. Sunlight direction in different seasons is a factor influencing the orientation of buildings in a site. In Greeks, the primitive builders put windows in southern facades to gain the sun heat, because they figured out that the sun crosses through the south in a low level during winter seasons. On the other hand, roofs were formed to shade the facades to avoid the heat produced by sun which paths across a higher arc. Stone, as the major material of the ancient buildings stored the sunlight heat (Oktay, 1999).

In traditional buildings, two general features are noticed in the choosing of materials. One of them is solar and thermal efficiency of the walls and external finishes. The second one is how the applied materials are self-efficient.

In general, the common building materials in old constructions in arid climates are adobe, stone, muck, soil and muck blocks. All of these materials are having some thermal properties that make them suitable for buildings in arid desert zones with hot days and cold nights. High thermal capacity, high heat isolating properties are all beneficial there. The colors of facades are light like mud, this is also beneficial to reflect the sun radiation during the day.

Then, Climate in desert regions has played a great influence on the architecture of house. This influence occurred in house layout (spaces configuration), buildings materials, envelope orientation and finishing, openings size, and narrow-covered non-straight streets. Builders of old dwellings in Ghadames city have used such techniques to provide thermal comfort as much as possible.

ii.Providing Privacy

The term of privacy has various definitions based on different cultures but generally, it can be defined as controlling the relationship between residences of the house and strangers and vice versa (Gazzeh, 2009).

Different cultures forces special features in building design. One of the important determinants of socio-cultural roles is religion which significantly affects organizing spaces of buildings. As Osivand (2013) represented, "*The categorization of construction culture shapes based on the factors of Human's primary needs such as sleep, food, marriage, need to private and public spaces, social interactions, family structure, Patriarchal, and female dominance*."(Osivand, 2013)

Therefore, architectural design of house is highly influenced by privacy issue, where the owner or the user has always taken into account privacy as primary requirement that is based on culture and religious issues. For instance, privacy is provided by dividing the house into different parts. For the external environment privacy controls the relationship between house and the ambient built environment.

Several scholars classified two different types of privacy that are influencing in house design: "*privacy from outside the house'* and '*privacy from common spaces in the house*".

One of the most impact factor on privacy could be religion. For Muslim societies privacy and visual privacy are crucial factors in designing Muslim houses.

The mode of occupants' lifestyle in a building, and how they use their dwellings, have a great effect on building forms. The size of family units, how food is prepared and eaten, how people interact and many other socio-cultural considerations which affect the arrangement of spaces and size of dwellings. For example, the family units of several East African societies live in multi-family residents surrounded by extemal boundaries, which separate between dwellings and the surrounded built environment. Social intervention within the family is controlled by privacy and the separating between spaces in which family members live. By contrast, in Western Europe, such segregation is achieved inside one dwelling, by dividing the building into separate rooms.Privacy as a cultural and religious requirement has affected the design and planning of Arabic-Islamic cities where houses built to open inside the courtyard and streets are covered and non-straight to avoid long visual axiswhich provides visual privacy (Rapoport, 2014).Mashrabiyat (covered windows) is another technique that used to reduce solar gain and to maintain family out of sight (Figure 2.2).

Figure (2.2) Mashrabiyat in old Cairo (left), Courtyard house in old Tripoli (middle), Narrow covered streets in old Tripoli (right). (source:www.greatbuildings.com).

2.6. Modern Houses

During the primitive and ancient times, man has developed his own house by local materials to adapt to climate and to meet socio-cultural and climate determinants where there were not standard textbooks on houses design at that time.After the appearance of the new technologies and the availability of the new materials, mass production in houses has begun. Where houses design was influenced whether in design or in construction materials.In Europe, BAUHAUS movement was a crucial stage and turning point in the history of architecture where the international style (which became the common style) has occurred during this stage. Wooden-stone houses with roman or Greek elevations were not used any more. Several houses were designed and built by famous architects such as F. L. Wright, Mies Van De Rough, Le Corbusier who designed Villa Savoye to be an example of modern concrete houses (Figure 2.3).

Figure (2.3) BAUHAUS in Germany and Villa Savoy
(Source:www.greatbuildings.com).

2.6.1. Definition of Modernity

Modernity is a concept that defined by the social scientists as all the developing countries have to follow the similar path as the developed ones in time. This understanding is called Modernity (Kongar, E., 1985).This approach became a theory of Modernity.

It has been in the nineteenth century where modernization took a place in several field such as economic and political fields. With the rising of industrialization, political uprising, new technologies and increasing of urbanization, modernity became more

than just a mental concept. It occurred in the built environment, and has led to transforming of human lifestyle.

Modernity has several sources of origin and indications in history. According to Whyte (2004) modernity has several meanings, it means current and actual, as opposed to past or new in contrast to old. Simon (2005), has defined modernity as the stage of the new. Modernity represents historical transformation through the range of disciplines, periods and positions by linking the events, humans and thoughts of the past to create an account of the meaning in the present. Hence, modernity is a period of constant transformation that influences all phases of experience from science and philosophy to urbanization and state bureaucracy (Simon, 2005).

The American cultural analyst Marshall Berman (1994) pointed that "*to be modern is to find ourselves in an environment that promises us an adventure, power, joy, growth and transformation and at the same time this transformation threatens to destroy everything we know, everything we have*". The core idea of Berman's suggestion is that to be modern is to be in conflict with confusion and transformation (Simon, 2005).Thus, Modernity is a process of transformation from the past to the present or from the old to the new, where thoughts, cultures, events are transferred.

Heynen (1999) categorized the thought of modernity within three attitudes: the first attitude refers to the present as the opposite of the past; the second attitude refers to the notion of new in contrast to the old; and the final attitude is transient. Hence, the present, the transient: and the new all these attitudes describe the idea of modernity which takes a place by few achievement mechanisms.

2.6.2. Modernity Achievement Mechanism

Understanding modernity and its mechanisms ofachievement in architectural design can be conducted through the procedure of Adaptation and transforming (change). For more understanding, these mechanisms will be clarified briefly.

i. Transformation (change)

Inglehart (2005) argued that modernity is referred to the new meanings and it is a process of change and gradually becomes aesthetics of the change. While Watson (2007) added that the process of change includes the human intervention to shift the mores and cultural values.

The architecture as a cultural value is one of the objectives of change. Schulz (1971) mentioned that the change in architecture takes a place by three main elements the need (the function), the man and the technology.

According to the famous sociologist (Murdoch) who prepared his study under the title of "How Culture Changes", Change or renewal can be classified into four categories as follows:

a) Variation: It is a continuing modification of the existing form and a gradual change to enhance the system specifications.

b) Cultural borrowing: It is the including of historical and heritage properties and their transfer to a modern form.

c) Invention: It is a changing and shifting of the relations within the rules of the system.

d) Temptation: It is a splitting of traditional laws and a challenge to the dominant system. It aims to establish a new order with new elements (Razuki, 1996).

Therefore, modernity can be clarified as the level or degree of transformation that the study will depend on in the next chapters.

According to the degrees of change (Al-Shwani, 2011) can be summarized in the following five categories:

a- No change: Simulating or copying the origin without any modifications

b- Minor change: Fractional change of system components.

c- Adaptation: Mixing the origin (source) with new components.

d- Major change: Changing relations within the order.

e- Total change: converting the system relations and regulations

Consequently, the first degree of change could be considered as a copy and paste process, whereas the second, third and fourth changes are under transformation procedures and the last change is under the concept of splitting or rupture, which skips any relation with traditional sources. This classification would be the scale for measuring the influence of transformation process to modernism on Ghadames houses (Figure 2.4).

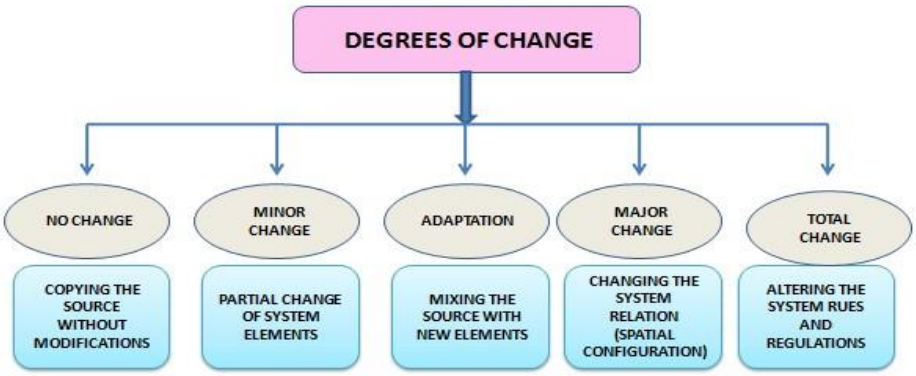


Figure (2.4) Degrees of Change (source:Al-Shwani 2011)

ii. Adaptation

Adaptation in architecture is a procedure that can be defined as the generation of a target model from a source model (Brawne, 1992). This idea has also been utilized to connect the form adaptation and the architectural meaning as a maximum response to external and internal forces (Watson, 2002). The term transformation in the English language means the act of changing in form or shape or the occurrence of an object (Hornby, 2005). Adaptation means a change of shape, form, or structure without a loss of substance. It includes two main different steps: adaptation of material and adaptation of content (design spaces), (Hays, 2000).

The idea of adaptation is detected by the truth that any system capable of working must be integrated and balanced to carry a special properties related to its originals and featured from the rest. Due to this reason, Antoniadis (1992) clarifies adaptation through the visual analysis of the plans on the grounds that the change in architecture is

physical and moral changes on the main sources. Ekomadyo (2007), mentioned that adaptation is a procedure of investigating the sources of architectural form and reshaping them in a new form that is modified with its ambient context. According to the mentioned above attitudes, the procedure of transformation can be achieved through the following options:

i. Reforming an object

ii. Changing its internal pattern

iii. Visual changes by transforming physical and cultural aspects of form

iv. Straight adaptation and intervention between various culture shapes

2.6.3. Modernity in Architecture

Architecture has passed through various historical stages. Each stage has its specific features, cultural and philosophical background and historical development. To figure out the impact of modernity on each period, the study will inquiry and find the sources and origins of modernity in each phase.

According to (Peter, 1994; Khanuddin, 1998), the modern movement of architecture was an evolution that demolished the existing classical architecture and replaced it with a new order. The beginning of the modern movement goes back to the democratic movement and industrial revolution (Scully, 1975) where a new style had occurred in many Western countries with the concepts of "*logical or rational*" use of modern materials, the functionalist planning, and the rejection of the classic style. The relationship between modernity and architecture could be classified into Modern Movement, Post Modern Architecture, Post Structuralism and Deconstructivism.

i. Modern Movement

This movement has occurred in Europe where the influence of Bauhaus on modern architecture was outstanding. In the early period of twentieth century, the Bauhaus, as the pioneer of the avant-garde, provided the modern movement a philosophical and

practical ground. Accordingly, concept of modernity is developed by the new designing ideas of five scholars of modern architecture namely Walter Gropius, Le Corbusier, Mies van der Rohe, Alvar Aalto, and Utzon. For Molnar (2005) modern architecture as the architecture of functionalism to address a new sense of space supported by new technologies, methods and modern materials. The modernist principle of "*form follows function*" proposed that the form and appearance of new buildings should grow out of their applied materials and structural design, It requires gathering and creating harmony between function, technology, and aesthetic expression. In the point of view of Vidler (2000), modern architecture is that which represents space and metaphysical form and avoids the decorative and constructional systems of traditional or traditional architectures.

Modern architecture and International Style rapidly scattered around world to become the common architectural style. The modern style of architecture was produced by modern movement which was an evolution that demolished the existing classical architecture and replaced it with a new architectural style (Peter, 1994; Khanuddin, 1998). The starting point of the modern movement returns to the democratic movement and industrial revolution (Scully, 1975; Peter, 1994). It was a new style that came into view in many Western countries with its fundamental concepts of "*reasonable*" utilizing of modern materials, the principles of functionalist planning, and the revising of the classic model.

Finally, modernity in the period of modern movement can be crystallized into three principal themes: Memory, Expression, and Morality (Gibson, 1984).

As a conclusion, modernity in the time of the modern movement in architecture is a passion for the new. It is a concept of rejecting tradition to produce new forms. It is an exploration of possibilities and a continuous seeking for uniqueness and individuality.

ii. Post Modern Architecture

Jencks (1991) pointed that the great variations of modernist architecture, industrialization of construction, prefabrication and functionalism interpreted has led to the failure of modern architecture. This reason caused the appearance of Postmodern

architecture (Venturi, 1992).In the seventeenth of last century, Venturi had leda new generation of architects to conflict against the featureless nature of modern architecture. They decided to mix between new modern technologies and traditional forms from different historical stages. Postmodern architecture has also been represented as *"neo-eclectic*" by bringing back the reference and ornamentation to the façade and substituting the forcefully unornamented modern styles (Jencks, 1991).

Postmodern architecture is a hybrid style with a positive approach toward metaphorical buildings, the vernacular, and a new ambiguous kind of space (Jencks, 1991). Postmodern pattern searches for several architectural styles in different historical stages to become eclectic and involves a return to the past as much as a movement forward by employing new materials and resisting the matchmaking of the International Style. For Nesbitt (1996), postmodern architecture addresses a crisis of meaning in the discipline of architecture. It is a sensitivity of addition in a period of multiplicity (Derani, 1994).

For instance, the thought of Modernity in postmodern architecture can be classified into the following three directions:

a) Renew the features of classical architecture by copying the techniques and classic elements as the main sources for design.

b) The juxtaposition of multiple layers of traditional, contemporary and newly invented forms to create multiplicity in architecture.

c) Using of modern technologies and re-addressing the crises of meaning in architecture by mixing styles based on three main details: the context of the building, the variety of its function, and the specific taste of the culture of its users.

iii.Post structuralism and Deconstructivism

This movement has occurred in the late nineteenth of last century as a development of postmodern architecture where it was introduced by concepts of deconstruction, incomplete and non-organized forms instead of organized, and dynamic forms (Kipnis, 1997). The visual formation of deconstructivist architectural style is known as a

motivating randomness and a controlled chaos. Deconstructivism in modern architecture rises in opposition to the well-organized logical style of modernism. The generation of deconstructionist style is not based on the physical matter of space, but rather on spiritual matter, which is extracted from the concept of space in architecture. Therefore, the core of deconstruction is to see things with a critical eye and to have a worldwide vision transcending time and space (Burke, 2001).

Modernity in deconstruction architecture can be clarified within the idea of displacement which aims to re-organize the characterized view of a building, revealing its inside formerly invisible aspects of its outside, reconstructing different adjustments of space, forcing different concepts of access, and replacing the principles of *'what it contains*'.

Then, modern architecture through history has crossed several historical stages, in each stage the architectural style was influenced by specific factors that led to develop or to create new different architecture. House in Libya as an important element in the urban development was not an expectation of this where it had been affected by many factors through different historical stages.

2.7. Libyan Houses and Modernity

The Libyan house has developed through history from primitive shelters (wholes) in Gharyan city to tents in desert and mud-stone houses in which are scattered within eastern, western and southern regions. Previous studies have been done on the history of Libyan house pointed that traditional houses remained till the Italian colonisation.

According to (Shawesh, 1996), houses in the Libyan cities could be classified into primitive-classic (traditional) dwellings which they were built during Phoenicians, Greeks, Romans, Ottomans (Figure 2.5)and finally by Arabs while modern concrete houses occurred firstly during the Italian colonization period in 1911.

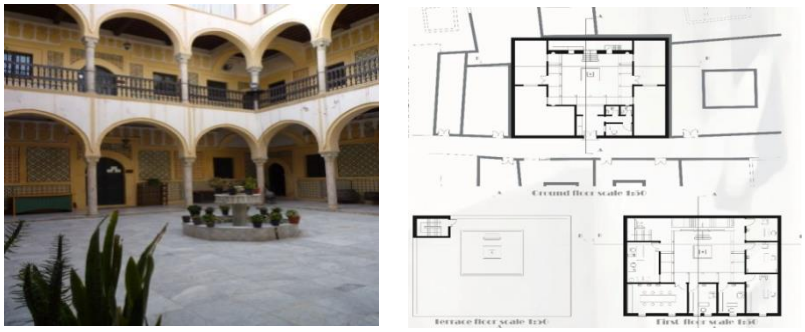


Figure (2.5) Traditional Ottoman House, Tripoli city (source, author).

The Italians attempt to create new house with European style and replacing the compact urban texture of old Libyan cities such as Tripoli, Benghazi and Ghadames with modern-wide streets, and squares instead of traditional covered markets. These attempts were made to transfer their architectural style and their urban development to the Libyan settlements. The influence of Italian architecture could be classified according to the following stages: (Figure 2.6)-

A- Stage1 from 1911-1913

At this point the Italian army is controlling scattered spots on the Libyan soil, during this time simple army houses were built on the coastal zones.

B- Stage 2 from 1913-1923

The Italians in this stage have controlled over most of the coastal and middleregions and start to create a corporation with local citizens and built new buildings such as houses, military facilities, administrative buildings, and schools. Fuller, 1992 mentioned that the Italians tried to learn from French experience in North Africa by

Figure (2.6) Italian Military House in Libya (source, Shawesh, 1996).

trying to give new life to the Arab residents whom rejected this new different architecture.

C- Stage 3 from 1923 to world war2 (fascist period)

During this history fascists took over all Libya and tried to force the fascist architectural style to be the common style as a symbolism to the fascist regime in all Libya where the old wall of traditional Tripoli was demolished at this time and the vernacular settlement was surrounded by new-modern buildings with Italian architecture and old-islamic Tripoli became a part of the new city.

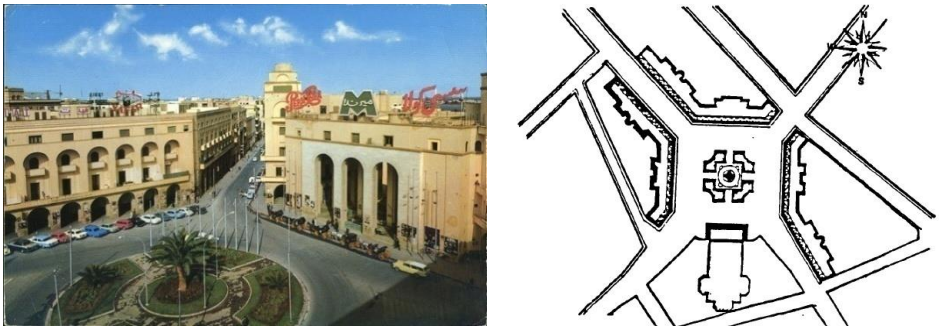


Figure (2.7) AL-Jazair square an example for Italian plaza (source: Shawesh, 1996).

After the end of World War2 the Libyans gathered themselves and gained their independence in the 28th of December 1951 and Libya has become a kingdom under the role of the King Idris. During this period the king Idris declared a national housing program to provide modern house for Libyans, the government called a western company (Doxiadis associates) to prepare a study about the housing conditions and to suggest solutions to this problem. The company designed new houses and built some

samples in Tripoli and Almarj city. The reason behind Idris housing project was the slums and shanty towns that surrounded the big cities Tripoli, Benghazi, Sabah l
Later, in 1969 Al-Qaddafi had led a military coup and took over Libya, the government at this time attempted to build urgent housing project where it made contracts with foreign construction companies to design and build modern residents with water, sewage network, electricity and parks.

The following figure shows the historical stages of Libyan house (Figure 2.8a).

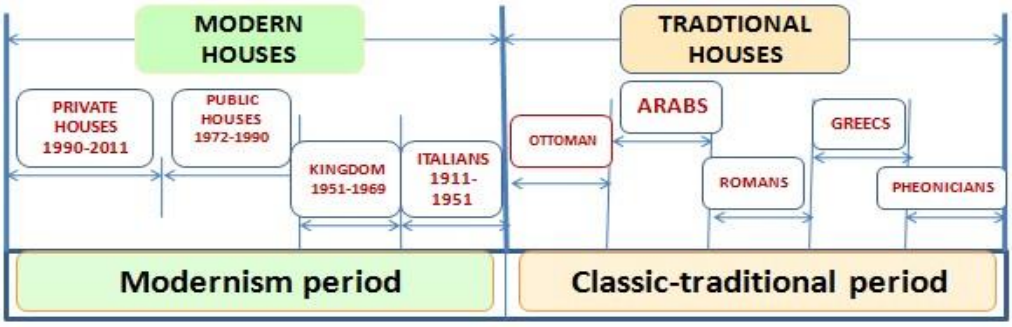


Figure (2.8a) historical stages of Libyan house (source: author).

Several studies had been done to assessment the occupants satisfaction in these modern houses. According to Kezeiri, 1984, several problems occurred in the new dwellings such as:-

1- Dissatisfaction with climate and socio-cultural conditions.
2- The need for more privacy in the design of units.
3- Bad locations in terms of accessibility.
4- The need for more maintenance and repairer.
5- The absence of traditional buildings experience makes the new houses are totally different from the architectural style of local Libyan house.

In Ghadames city modern houses occurred in the Italian period where they built few houses for the Italian governor and his staff. Later in the seventeenths of last century the government decided to build new public houses to transfer the inhabitants of traditional town to modern settlement (see figure 2.8.b).

Figure (2.8.b) Sample of New Public Houses. (Source: Alabid and Taki)

At the end of nineteenths of last century the government started supporting private housing program by giving loans to the people and they build their own houses according to their desire.

In the following chapters study aims to figure out how modernism influenced the architecture of desert house of Ghadames city.

3. THE ARCHITECTURE OF GHADAMES HOUSE AND MODERNISM

Ghadames city was built through history in the middle of an oasis in Libyan desert. The city was built gradually where houses form layers attached to each other layer after layer from the ancient times where Ghadamesian builders have presented a unique architecture.

In the present time the city is consisted of two main parts which are:-

a- The old town

b- The contemporary city (see figure 3.1).

c- The contemporary part is being considered as a result of the influence of modernism.

3.1. Location

The city of Ghadames is located in the western region of Libya (Tripoli region) near the intersection between Tunisian, Algerian borders. See figure (3.1)

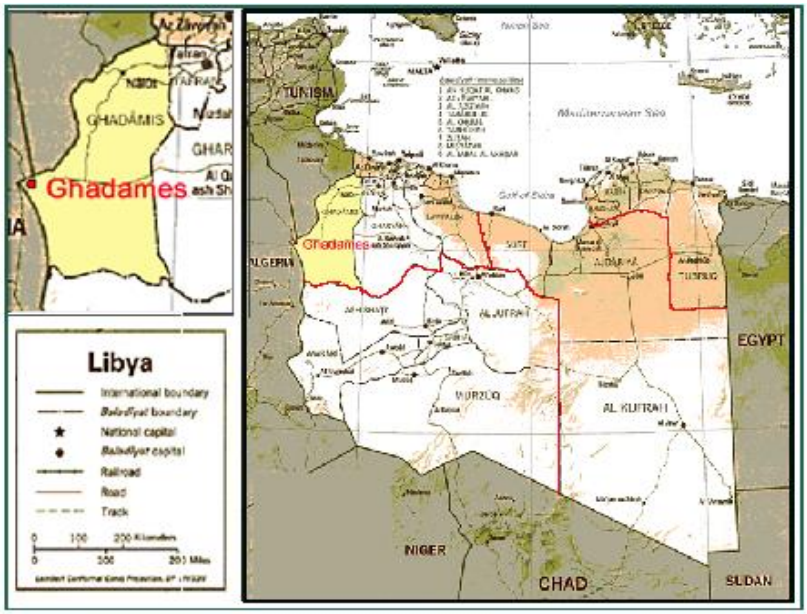


Figure (3.1) Location of Ghadames.

The old city of Ghadames was established in the middle of an oasis with position of 30.08 N and 09.3 E. it is about 600 Km from the Mediterranean sea coast and about 300 m over the sea level where it is surrounded by sand hills (Rava Carlo Enrico 1998).

3.2. Historical Background

Previous historical studies pointed that Ghadames city was established 4000 years ago, and occupied by several civilizations which had contributed in the growth of Ghadames. Historical staged of the city could summarized as follows:-

a. Foundational Stage: During ancient times, Ghadames city was considered as a meeting and rest point for convoys that are coming from middle Africa to coastal regions of North Africa and that are coming from east to west. According to several archeological studies this period goes back to about 4000 years ago.

b. Greek Period: This stage went back to Paleolithic and Neolithic times.

c. Roman Age: In 4-5th centuries, the city was taken over by Romans to be a military base for defending the empire borders from barbarians attacks. The roman castle in Ghadames is a concrete evidence for their existence

d. Islamic Age: The age of Islam in Ghadames has begun when ARAB-MUSLIM armies came into the city in the 7th century.

e. Italian Colonization Stage: In 1914 Italian soldiers had colonized the city which remained under the Italian administration till the French period.

f. French Colonization: During Second World War the city had witnessed a conflict between Italian and French armies which finally took over the city in 1955.

g. Modernity Period: Several historians believe that modern age of Libya has started from independence day in 24th of December, 1951 where Libya had become a kingdom under leadership of the king Idris AL-ssanousi. During this time oil has occurred and the economy of Libya has changed. Government had started a transformation from traditional housing to modern housing provided by electricity,

infrastructure, sewage, and water supply networks. In the 1st of September 1969, Al Qaddafi had led a military coup against the king and took over Libya and rolled it for 42 years till he was killed by Libyan rebels in 2011. At the beginning of the seventeenths of last century, Libyan government had decided to build new housing projects to move Ghadames citizens from vernacular settlement to modern houses. New houses were designed and built by foreign designers and built by new hand-made concrete materials (Figures 3.2.a, 3.2.b).

Figure (3.2.a) The Old Town and The New City of Ghadames

Figure (3.2.b) The Old Town and The New City of Ghadames

3.3. Society and Social Structure

According to the in-depth interviews with elder citizens and historical studies, the social structure of old town was mainly formed by three main tribes, each tribe includes number of families which are related to each other by blood tie, traditions and mores. The main three tribes of old Ghadames are:-

Ben-Waziet, Ben-Waleed, Tuareque. Tribes of Ben-Waziet and Ben-Waleed are considered as the original occupants of the city whereas, Tuareque settled later.

The inhabitants of old town had moved to the new part which contents new modern housing projects and the social structure remained the same.

3.4. Geographical Features

The old city of Ghadames was established in the middle of an oasis in desert region, this oasis contents thousands of palm trees which form a heavy thick green belt that provides protection from harsh climate conditions.

The oasis of Ghadames lies within Al-Hamada Al-Hamraa plateau surrounded by a salt marsh which is covered by sand hills in the western side whereas in the east side is covered by rocky outcrops covered by sand. The geological layers contents limestone, gypsum, dolomite and sand sediments of fluviaeolian origin. These materials are considered as the main source of construction materials of traditional settlement.

3.5. Climate Data

Desert regions are known as the most tough and harsh climates around globe. The main determinants of each climate are temperature, relative humidity, sun radiation and rain fall.

i. Temperature

In general, climate of arid regions are characterized by high temperature-dry summers and cold- semi dry winters. In specific, winters in Ghadames region are characterised by warm days and very cold nights where temperatures fall to about 0.0^0 C to -5^0C . Summer days witness high temperatures range between 45^0 Cand 50^0 C at daytime (Figure 3.3).

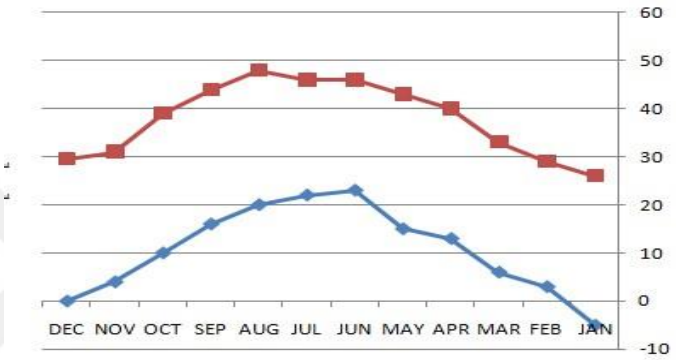


Figure (3.3) the average of annual temperature (source: The meteorological office)

ii. Rainfall (perception)

According to Köppen (1983) climate map the highest level of perception around world is in the equatorial regions where it achieves 3000 mm while most of the Arab countries located in hot arid and semi-arid zones which are characterized by low levels of annual rainfall (less than 100 mm) see (figure 3.4, figure3.5.).

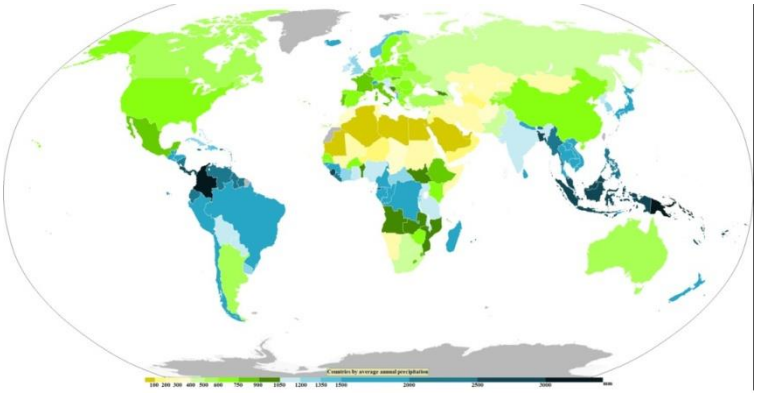


Figure (3.4) Climatology of Annual Perception Around Globe (source: Köppen 1983)

The annual perception in Ghadames climate according to the meteorology office in the city is about 75 mm. therefore the region of Ghadames is classified as arid dry zone.

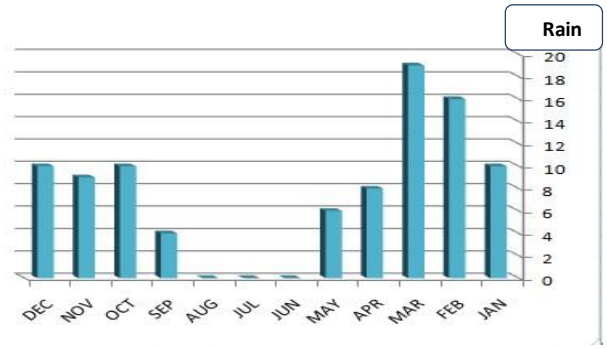


Figure (3.5) Annual Rainfall in Ghadames (source: meteorology office).

Meteorological records show that the maximum annual rainfall was about 183 mm in 1976 while in 1974 was the minimum rainfall value with about 66 mm and the maximum daily rainfall was in March 1974 which was 44 mm (Ahmed s, 1988).

iii. Solar Radiation :

The amount of sun radiation depends on the required time for sun movement from sunrise to sunset. According to Köppen (1983) climate zones, Ghadames city is located in the area of 2300-2500 KWh\ m^2, where the maximum amount of solar radiation in the world is 2700m KWh\ m^2.

Solar radiation plays a major role in gaining heat and thermal comfort in dwellings where the more amount of solar radiation, the less thermal comfort is.

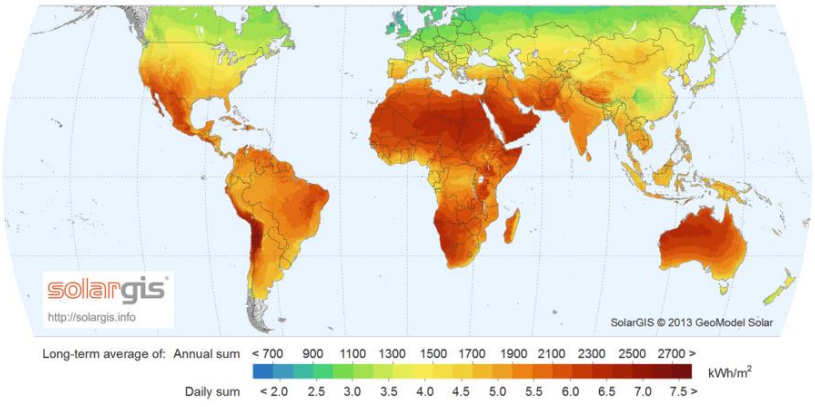


Figure (3.6) Solar Radiation in the World (Source: Köppen 1983)

iv. Wind and Air Currents

Records of meteorological office of annual winds in Ghadames city shows that the most common winds during the year is East winds with ratio of 14% while the less prevalence winds is North-East air currents with 6% of total.

The speed of winds in Ghadames environment ranges between 8-12 Knots/hr. summer seasons of Ghadames witness hot sandy winds with speed of 50-75 Knots/hr which locally called (Al-Gibli). This type of winds causes rising of ambient temperature (Figure 3.7).

Then, city of Ghadames was built in the middle of an oasis located in the middle of desert environment which is marked by harsh climate conditions.

Therefore, constructing dwellings in such environment requires taking into consideration the effect of climate on human comfort in houses as well as socio-cultural needs.

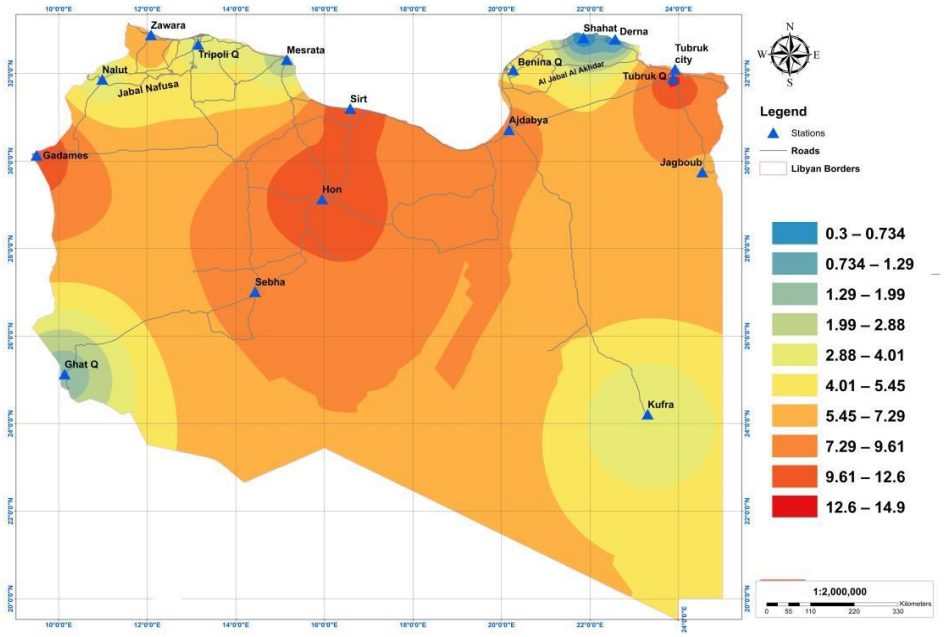


Figure (3.7) Summer Winds in Libya (source: Atlas of Libya).

3.6. Housing Typology in Ghadames

In the present time, Ghadames city consists of two main parts, traditional settlement which was announced under the world heritage in 1975 and the contemporary part which is built in different date and different architectural style.

3.6.1. Traditional Settlement

As mentioned above, the traditional settlement was built in the middle of an oasis where the water spring of (Aien-Alfaras) and the validity of palm trees are the main factors of the establishment of the traditional town.

The old town was built and rolled according to socio-cultural and climate requirements. Piccioli, 1935, pointed that few places on earth, I believe, is no dominate as at Ghadames by that singular charm which is exercised by traces of a vanished way of life, of a world that has lasted from immemorial times. Everything here is as it has been for centuries. Socio-cultural and climate needs had a major contribution in shaping the landscape of the town and the separation of spaces into public and private could obviously be noted.

The tribal social structure has affected the formation of the settlement where it was divided into seven neighborhoods each neighborhood was occupied by a tribe or sub-tribe. These neighborhoods are:-

Tangzin, Tusku, Giorsan, Tharefra, Mazigh, Djarrasan and Aulad Belal. Each neighborhood has a central meeting square (occupied by males) and mosque (figure3.8).

Figure (3.8) Ground Covered Streets for Males and Top Roofs Passages for Females (source by author).

The whole settlement connected to each other by ground covered passages network while women and girls move on top floors using a complex networks of passages and stairs. The whole oasis is surrounded by a thick wall in order to provide security from enemy attacks as well as desert creep. The external wall contents more than ten gates which were guarded to be opened at daytime and closed at night (Fathi, 1998).

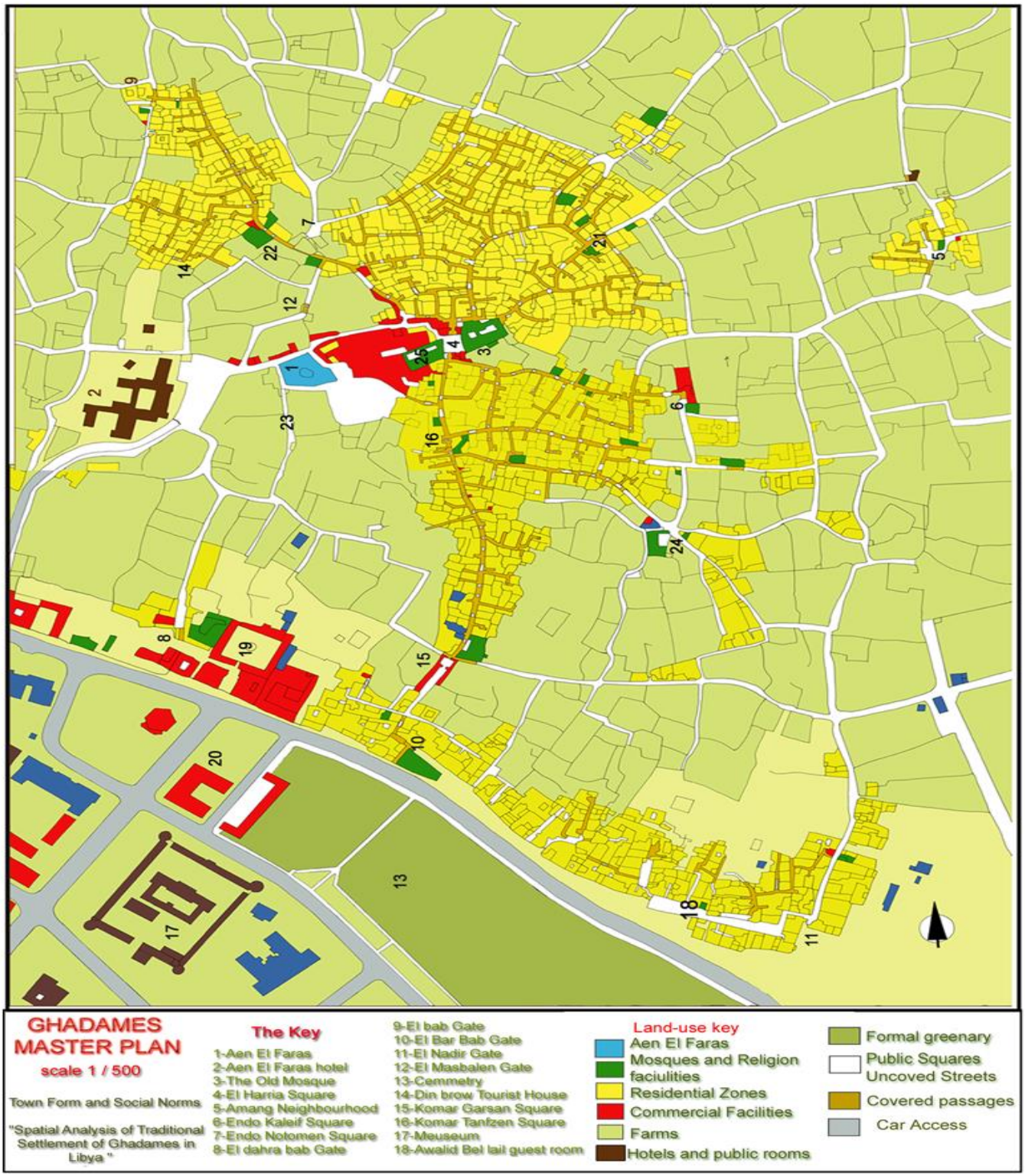


Figure (3.9) Plan of the Old Settlement of Ghadames

(source Ghadames Baladyah 2002).

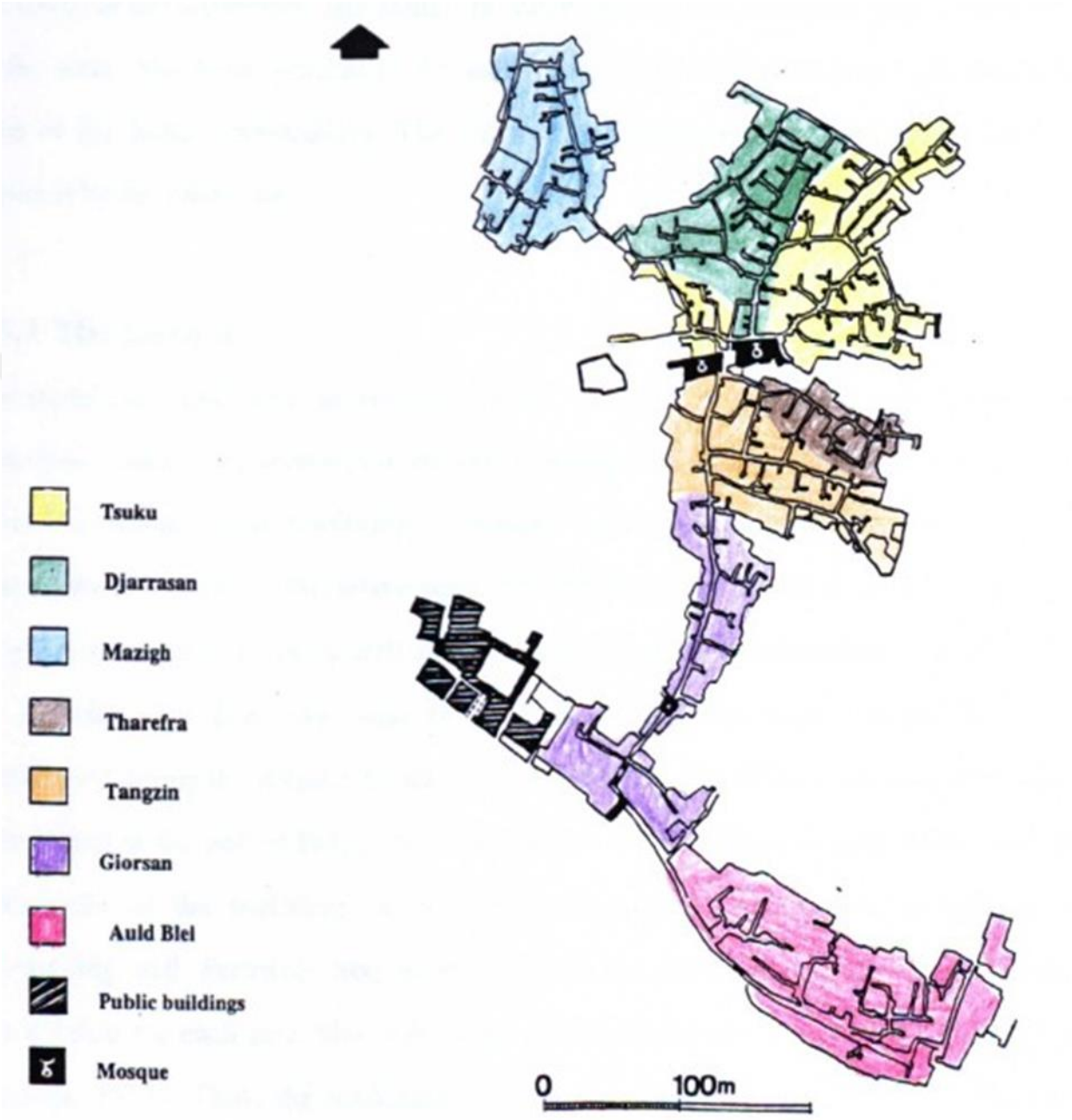


Figure (3.10) Neighborhoods in Traditional Settlement (source: Lars Eldblon 1968).

3.6.2. Traditional Houses in Ghadames

Piccolo (1935) mentioned that Ghadames stands like a fortress against the sun and the desert. it seems rather like a giant coral reef. One thinks of it as the slowly extended crust of collective life that has gone on through generations of always similar individuals, as a natural product that has arisen spontaneously through thousands of years. (See figure 3.11).

The term of natural product referred to that traditional houses were built organically through history by local natural materials, these houses are attached to each other forming a compact fabric with a unity and harmonious in terms of the architectural style.

Figure (3.11) Group of Traditional House

i. Constructing Materials and Methods

The influence of local environment obviously occurred on the architecture of vernacular dwellings. The structure of classic muddy buildings has resulted from the types of building materials that are extracted locally such as lime stones, gypsum, and palm trees trunks and leaves. As well as mud and straw.

The experience with local construction materials and the economics of society are the main determinants of the selection of dwelling size and materials. The local building materials are lime stone, pumice stone, mud (clay), gypsum, palm tree leaves, stalks and trunks, chopped straw.

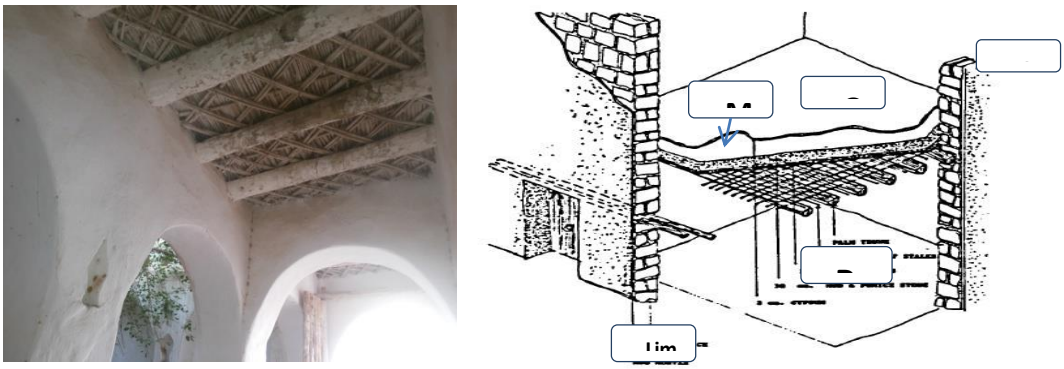


Figure (3.12) Building Materials of Traditional House (source, Shawesh, 1992).

The process of constructing starts with foundations which are built by hard limestone linked to each other by mud mortar. The next step is building the walls, during this stage builders made walls by using sun-dried bricks which are made of mud and straw mixture and left under sun for at least year. Walls begin with thickness of about 60 cm in the ground floor while thickness of first floor walls is about 50cm whereas it is about 40cm in top floor. (See Figure 3.12).

During field survey of traditional settlement, few ruined houses show that roofs in traditional houses are made by distributing a number of palm trunks (half trunk or/and complete trunk) which are covered by net of palm trees leaf stalks distributed in two directions, this net of stalks is carrying mud concrete which is made of fresh mud and small pumice stones. The finishing layer is gypsum cover.

The traditional dwellings of Ghadames successfully stand against desert climate conditions. Hassan, 1982, stated that the traditional Ghadames house could be described as a museum representing the family and its preceding generations.

ii. Spatial Configuration (layout)

According to Shawesh(1996), the main considerations in Ghadames traditional house are the need of privacy, safe, and protection from climate. However, one of the most effective factors in organizing spaces within residences is gender segregation which influenced directly on house layout and its spatial configuration, where houses are

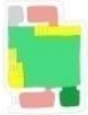
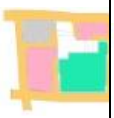
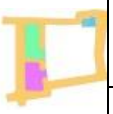
divided into three floors, ground floor contents main entrance and storage rooms. While first floor is consists of living space (sometimes used as male guest room), bathroom, furniture and clothes store, bedrooms and stairs. Top floor contents kitchen, roof terrace and summer setting place in some dwellings.

The total plot area of traditional houses ranges from 25 to 50m^2 while roof area is between 70 to 90 m^2, whereas, first floor is the biggest floor area with 70 to 120m^2 in some exceptional houses floor area is bigger.

Most of vernacular units are linked to the external covered street by only one entrance which is made of pal trunks with 80 to 100 cm width. The next table presents two models of traditional houses and their spatial configuration.

Most of old dwellings were built in three floors, ground floor consists of entrance, passageway, and storage room where the first floor contents living hall (central hall), bedrooms and bathroom. The kitchen and summer living place is located in top floor which opens on roof terrace.

Table (3.1) Spatial Configuration of Traditional Houses.

samples	H1			H2			H3			Colors key
floor	 ground floor	 first floor	 top floor	 ground floor	 first floor	 top floor	 ground floor	 first floor	 top floor	storage stairs
Roof area	28.5	61.87	51.65	50.23	155.55	57.52	33.6	58.02	51.5	bathroom
content	Main entrance. Storage. Stairs.	Bath room. Living space. Bedrooms Husband place. Storage	Kitchen. Women stairs.	Main entrance. Storage. Stairs	Bath room Living space Bedroom Husbands place Storage	Kitchen. Women stairs Summer place	Main entrance. Storage. Stairs.	Bath room. Living space. Bedrooms. Storage	Kitchen. Women sta Storage	living space husb. place kitchen bedroom

3.6.3. The Architectural Features of Traditional House in Ghadames

The architectural features of Ghadames house has been studied in different scientific fields and by several famous scholars. Study would depend on in-depth interviews results that deeply analyzed the architecture of traditional residents, these features could be summarized as follows.(See Table 3.1)

In this study, an in-depth interviews had been done with users from different ages, genders (60 person), and professions. According to results of this process, old dwellers who lived in both traditional dwellings mentioned that:-

a. Gender segregation, visual privacy and controlling social interaction are very important factors in Ghadamesian culture and main determinants in building houses layouts, streets networks within neighborhoods and the whole city.

b. Traditional houses were built by materials that are taken from surrounded natural sources and the way they were built in is very success in terms of thermal performance efficiency.

According to the previous approaches, the main architectural features of traditional houses could be summarized as follows:-

1. Traditional houses in different location around the world are characterized by using natural-local materials.
2. Socio-cultural factors such as social interaction and privacy are important determinants and they have a great influence on house design (house layout).
3. In hot arid (desert) regions, climate conditions are crucial factors in forming residences and the perfect thermal performance of buildings is highly required.

Since the study analyses the influence of modernism on the previous features, it suggests an explanation of the relationship between house and modernity.

3.6.4. Contemporary Settlement and Houses

After the appearance and production of oil in Libya, the economic growth increased and the socio-physical features of Libyan cities were affected. Like the other parts of Libya, Ghadames city witnessed a mass production of new modern housing projects. During 1978, ministry of facilities in Libya signed a contract with polservice-wadeco

consulting office (Shawesh, 1995), this contract was arranged and signed to prepare an urban planning studies for Ghadames city and its development directions as well as develop possibilities till the year 2000. Consulting office prepared and handled the master plan and urban planning studies in 1981, the modern master plan is consists of

town centre which includes governmental, public, administrative, health and religious facilities; four main neighbourhoods; open and leisure areas.

According to in-depth interviews with elders, old designers, and old households the first modern houses were designed and built by foreign companies and designers such as polish and Turkish companies.

In the middle of seventeenths of last century Libyan government decided to build modern houses to be used instead of traditional mud houses, the modern city is located on the south side of Ghadames oasis and consists of modern functions such as health, education, administrative and public buildings, however, the most important par is the residential buildings where they form about 60% of the total area (El-Agory, 2009). (See Figure 3.13)

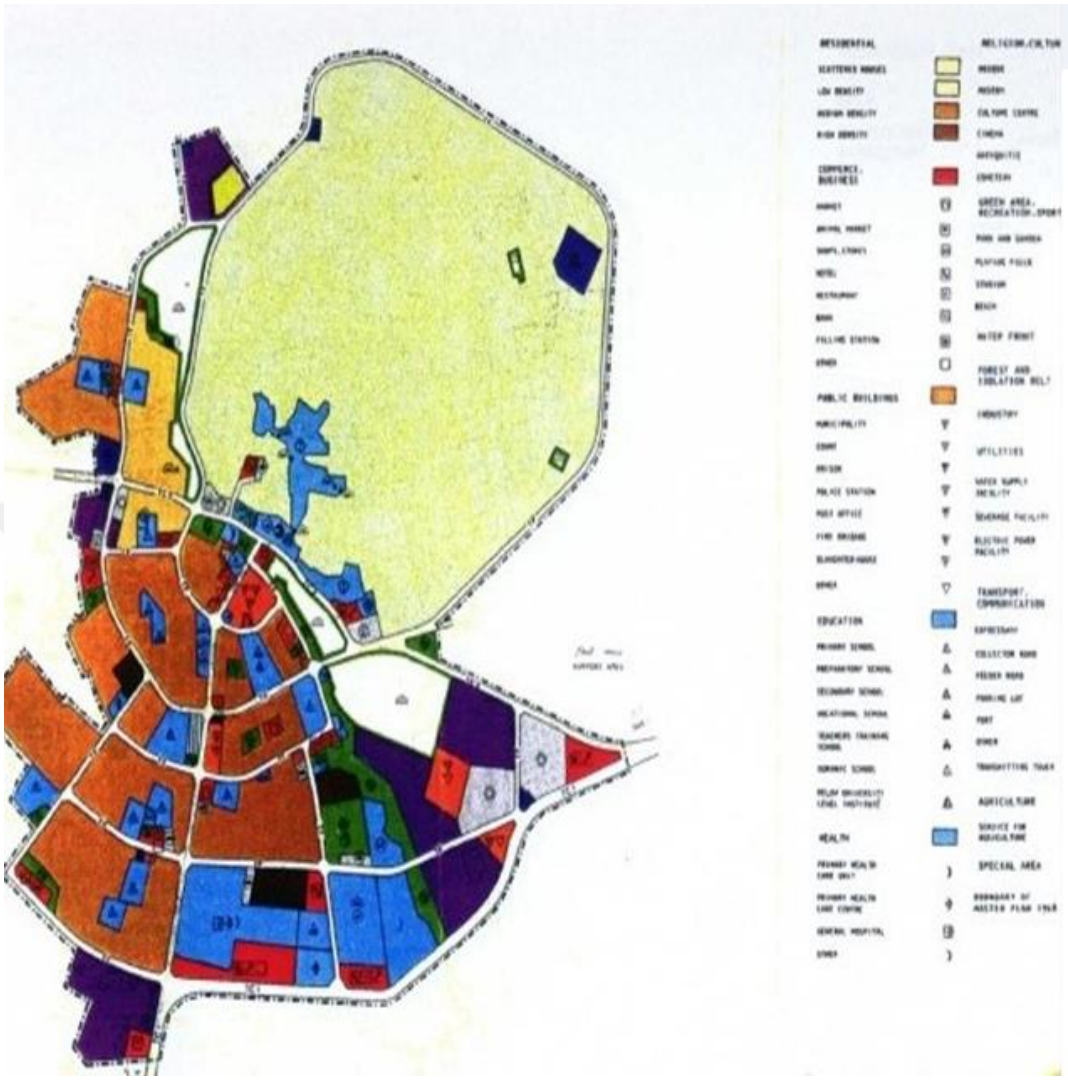


Figure (3.13) Master Plan of Development.

i. Types of Contemporary Houses

Contemporary houses in Ghadames are built during several decades, Ben Swessi, 1993 pointed that project of 616 units is one of the first modern housing projects that was designed by the polish designers Mika Ratshiva and Andrzej Zukowski and built by Turkish construction company(Ozdemir company for Constructions) in 1980.

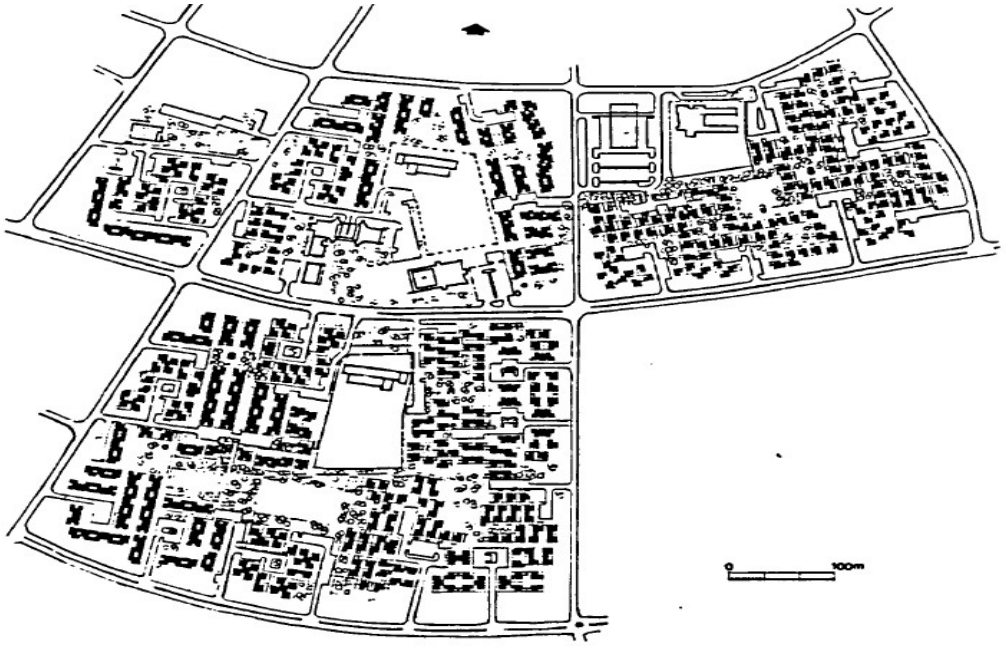


Figure (3.14) Housing Project of 616 Units (source Ministry of Housing-Libya).

During this period houses were designed and built by the under supervision of the government, this type of housing is called public housing (Figure 3.14, Figure 3.15).

In the following decades, housing policy o Libyan government has changed were citizens are allowed to have loans from banks (lending loans) for residential building purpose.

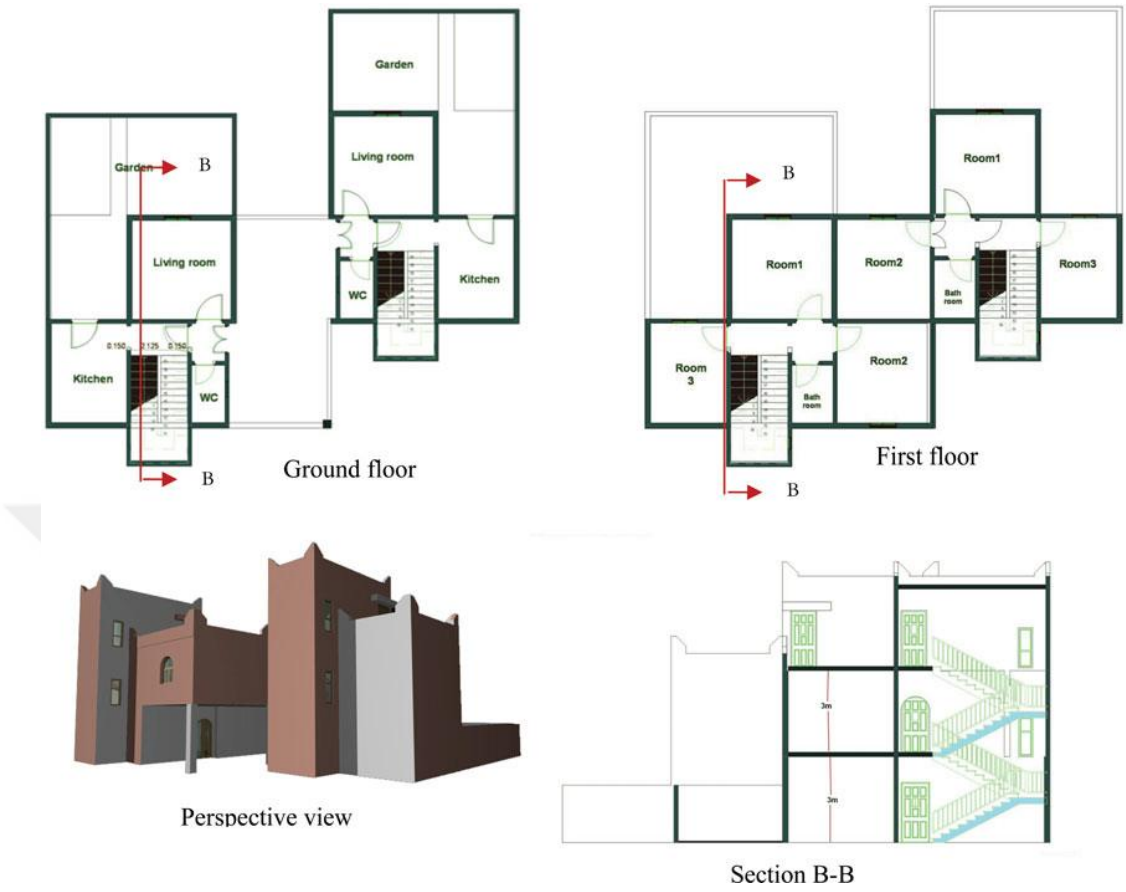


Figure (3.15) Public Houses in Project of 616 units (source).

Several factors encouraged dwellers of the old settlement to move to the new modern houses, these factors according to questionnaire results and in-depth interviews could be summarized as follows:-

1-Electricity, telephone, water supply.

2-Pavement roads and infrastructure.

3-Lacking of new houses.

4-New shape and architectural style that reflects the impact of modernity.

5-Mass production of new materials.

After the year 2000, the housing policy in Libya has changed from constructing public governmental houses to lending loans for land holds to build their houses according to

their desire. This policy caused creating new districts that content new houses which are totally different from each other in terms of the architectural design. (Figure 3.16).

Figure (3.16) Private Modern Houses (source: Author).

Occupants of old houses who moved to the modern dwellings believed that the new houses could insure a better and healthier quality of life (Shawesh, 1993).

Thus, dwellers of old town have built their neighbourhoods and houses according to their socio-cultural values and climate conditions, later they moved to new houses with ready designs (designed in advance) thinking that these houses could provide the same values of indoor privacy and protection from desert climate conditions (thermal performance).

ii. Construction Materials and Building Methods

According to field survey and the observation of construction process, nowadays houses could be described as a skeleton structure, where foundations, ground beams (ground ties), columns and roofs are built by using reinforced concrete while walls are built by hollow concrete blocks with dimensions of 20cm*20cm*40cm. these blocks are connected to each other by cement mortar. The main building materials in modern buildings could be summarized as follows: Cement, Aggregate, Sand, Constructional steel, Hollow concrete blocks, Wood and glass, Ceramic and marble. The following figure presents contemporary private house under construction (Figure 3.17).

Figure (3.17) Constructional Steel and Hollow Concrete Blocks. By author.

The constructing process begins by foundations and ground ties (ground beams) stage, where foundations are single-split made by reinforced concrete and ground beams work as a linkage between foundations. As soon as foundations stage is finished, builders work on constructing walls by using hollow blocks and forming the columns, the openings of doors and windows are left. After this step comes stage of roofs. The common constructional method of roof if by preparing the wooden form and distributing a net of constructional steel and then filled in the concrete. The final work in this process is the finishing, where walls are covered by cement mortar and paintings.

iii. Spatial Configuration of Contemporary Houses(Table 3.2)

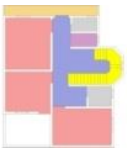
Despite, contemporary houses were built in different periods and different architectural style, they have a similar spatial configuration. Where dwellings mostly are single type with main mass surrounded by external courtyard and external wall. The main mass consists of one or two floors and two entrances. The main entrance is mainly used by family members and male guests whereas Sub entrance is used by family and female guests. The main entrance is directly connected to male guest room and its bathroom where male guests are not allowed to cross this line. Female guests and living rooms are placed close to the kitchen and main bathroom, this group of spaces are usually located in the middle of house plan. Boys' bedroom, girls' bedroom and master bedroom neither found at the end of house or in the first floor.

Spaces in contemporary houses are bigger than spaces in vernacular houses, where bedrooms range between 3.6m*4m to 4m*5m, while area of the kitchen is between 3m*4* to 4m*4.5m, whereas, guests rooms are the largest spaces with area of 4m*5m to 4m*6m. Bathrooms and store rooms area between 1.4m*1.8m to 2.5m*3m.

Then, modernity has affected the architectural features of desert house in Ghadames city, where contemporary houses were designed and built in completely different architectural style from traditional houses which were built according to socio-cultural and climatic determinants.

To figure out whether modernity influenced the architecture of desert house positively or negatively further methodologies would be used and comparative analysis would be required. Therefore, study is suggesting using scientific measurements to assessment the impact of transformation process from traditional architecture to the modern style on indoor privacy (socio-cultural value) and thermal performance (physical and climatic value) of chosen samples from both of traditional houses and contemporary houses. The next chapter would be for measuring indoor privacy satisfaction of users.

Table (3.2) Spatial Configuration of Contemporary Houses

samples	**H1**	**H2**	**H3**		Colors key
floor	 ground floor	 ground floor	 ground floor	 first floor	storage stairs
Roof area M^2	200	215	69.4	109	bathroom
contents	Main entrance. Male guest room. Main bathroom. Living room. Kitchen. Kids bedrooms. Master bedroom. Storage. Stairs. External courtyard		Main entrance. Male guestroom. Main bathroom. Living room. Kitchen. Stairs.	Kids bedrooms. Master bedroom. Storage. Balcony.	living space husbands' place kitchen bedroom

It is obvious that in sample1 the whole functions are distributed within the same floor while the contemporary house2 (sample4) divided into two floors the first floor is consists of semi-private and private spaces and the very-private (intimate) spaces are located in the second floor.

3.7. Sources of Modern Houses Design

During the empirical study and field survey, questionnaire (150 contributor) and in-depth interview (60 persons) had been done to investigate about the sources of modern units designs. According to results of both methods sources of modern designs could be classified into:-

a. Foreign companies who prepared designs of public housing units that were designed according to the modern life style requirements. This type of houses is located in the middle of the city and covers about 22% of residential land use in the

b. Designs that are quoted from other cities such as the houses in the capital (Tripoli) and Ghariyan. This type is about 34% of total housing area.

c. Designs that are prepared by local designers form about 38%.

d. Designs that are quoted from the internet (ready designs) form about 6% of houses.

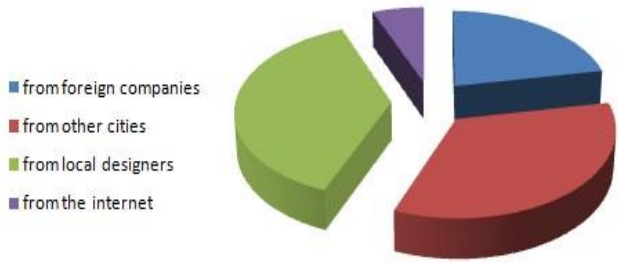


Figure (3.18) Sources of Modern Houses Designs. (Source, author).

Since, the study is attempting to analyse the influence of modernization on the main architectural features of desert house (privacy satisfaction and thermal performance) (Figure 3.18). Then, a comparative study should take a place to figure out to what extent transformation has influenced these features.

3.8.The Role of Designer in Modern Houses Design

Lerput (1973), stated that in early historical stages, building a house is a community task which is performed by the users themselves. This phenomenon still seen in the non-industrial societies. In the present time new buildings are built according to plans that are prepared by a designer or an engineer.

As Rapoport (1970), highlighted that the perfect design covers all needs of users. Therefore, many of differences (mismatches) between design and users' requirements are referred to the lack of conformity between the perception of designers and socio-cultural-environmental needs.

Understanding the relationship between space and human behaviour is very crucial factor in the process of design. In Ghadames houses privacy as a human need is highly required in house design and designers should take into consideration this requirement.

In the science of construction and built environment, climate and building materials are having strong direct relationship. Choosing the suitable materials is another task for engineers and designers especially in desert regions. Where, understanding the thermal properties of building materials enhances the thermal comfort inside dwellings.

According to results of questionnaire and in-depth interview with designers, the main considerations in design process are:-

a. Designing spaces is based on the modern life style requirements.

b. Spatial organization of modern houses designs is based on social relations and human behaviours.

c. Form (facades) is very important element, regardless arid climate conditions.

d. Choosing materials and methods of building according to validity, coast, and time instead of thermal performance.

3.9.Main Considerations in Modern House Design

Ziesel, (1995), represented that, when people see or read and analyse a plan they are reading behavioural applications of daily lifestyle that includes analyses of how users relate to their physical environment. This reading or this analyses includes:-

a. **Degree of privacy,** where people control social interaction according to their soci-cultural values.

b.**Personalization and territoriality,** where users control what they can use, change and how they behave (act) in their place.

For Rapoport, 2002, the main priorities in house design in desert regions especially in Arab-Muslim houses are:

a. **Socio-cultural forces**, such as privacy and social interaction.

b.**Thermal performance and Climate force**, Climate is a major force that directly affect building formation in hot-dry climates provides desirable thermal comfort.

During the field study, questions had been prepared to investigate about the priorities that should be given in desert modern house design, about 16 designer answered the following question:-

Priorities in desert modern house should be given to:-

1. Spatial organization and function	4. External facades
2. Spatial organization and furniture	5. Interior design
3. Spatial organization and privacy	6. Thermal performance and thermal comfort

According to results of in-depth interview, the priorities and according to designers should be given to:-

1. Spatial organization and privacy.	4.Spatial organization and furniture.
2.Thermal performance and thermal comfort.	5.Interior design.
3.Spatial organization and function.	6. External facades.

3.10.Interim Conclusion

The house in Ghadames settlement has been developed from traditional muddy-wooden houses to modern concrete building. The process of transformation toward modernity caused:-

a. The urban texture has changed from compact with narrow-shaded streets in old texture to separated buildings and wide open streets in modern developments.

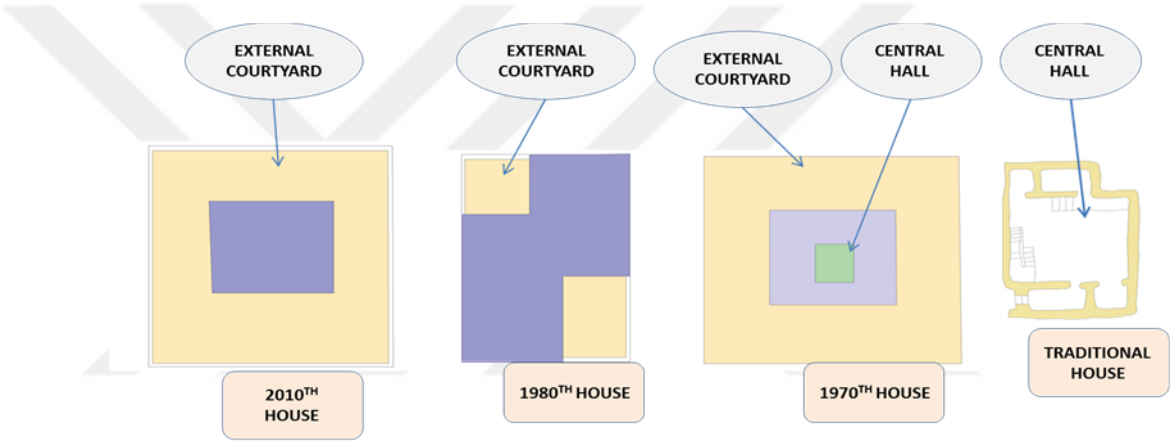


Figure (3.19) Historical Developing of Houses (source, author).

b. Changing in house design, where spatial-functional configuration of contemporary samples is totally different from traditional dwellings (Figure 3.19).

c. Replacing the local-natural building materials with new concrete and steel.

d. In terms of the architectural style, the huge variation in elevations and forms in contemporary dwellings makes them less harmonious than vernacular buildings.

e. According to degree of change scale (see figure2), the degree of change is a total change.

In terms of the architectural features of traditional dwellings layout, spatial organization, visual privacy and thermal performance are the main factors that effect on houses layouts organization.

For contemporary houses, priorities in modern residences designs are, spatial organization and privacy provision, and thermal comfort.

Therefore, these main elements would be use as a comparison elements between traditional samples and modern units to figure out to what extend modernity has effected the continuity of these features. (Figure 3.20).

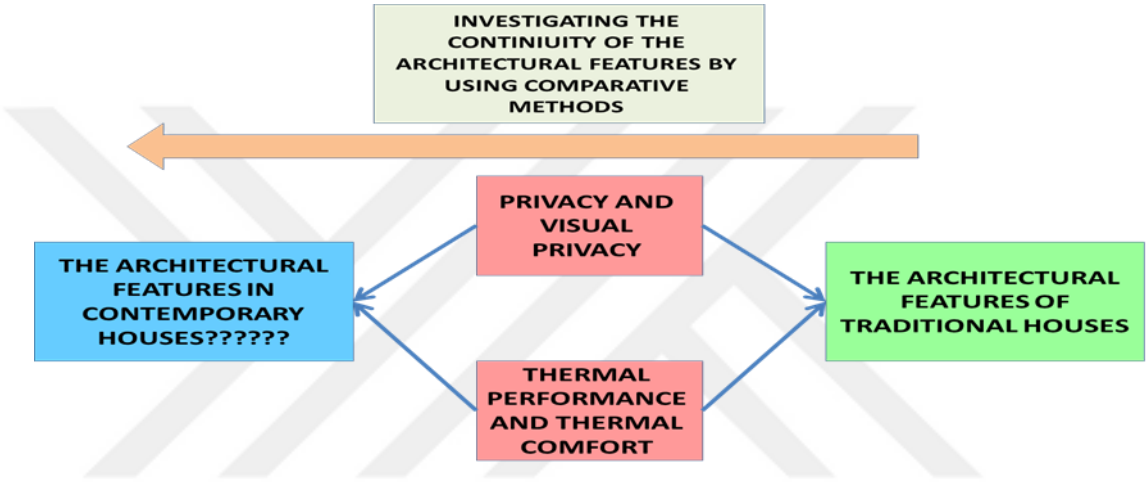


Figure (3.20) Comparison Scheme (source, author).

The following chapters would be to analyse the privacy and thermal performance of both traditional and contemporary houses.

4. THE INFLUENCE OF MODERNISM ON SPATIAL ORGANIZATION AND PRIVACY

The concept of privacy has been discussed in different disciplines such as psychology, law, information, and architecture. Where privacy considered as interaction process between individual and groups (society) or selective control of access to the self or to ones group (Altman, 1976).

4.1. Privacy Definition

Term of privacy is extracted from the Latin term (privatus) (e.g. withdrawn from public life) and (private) (e.g. to deprive). It obtains conventional opposition to public life during the sixteenth century and was considered to be a privilege, not a deprivation (Williams, 1983). Rapoport had explained the privacy as the ability to control intervention, to gain points, means and mechanisms to prevent unwanted interaction and to achieve desired intervention. Westin argues that privacy is the right of person or persons to decide what information about himself should be shared to others and under what condition (Altman 1976).

Several scholars have defined privacy in houses, Alexander (1977) mentioned that privacy is most urgently required and most critical in the place where people live. House environment should be built with privacy considerations. In almost every society the desire for privacy is an important social-cultural factor that influencing housing design.

Westin has classified the systematic analysis of privacy into four layers as follows:-

a. **Solitude**:where the person is alone and free from observation by others.

b. **Intimacy**: Includes segregation of small groups such as family members, from others.

c. **Anonymity**:It appears when individual is involved in public space (lost in a crowd) but does not expect to be recognized.

d. Reserve:Building psychological barriers against unwanted intrusion.

Then, privacy is an exchange process between individuals (persons) and groups (society).

4.2. The Importance of Privacy

According to social and psychological studies, human basic needs have been developed from protection (shelter) and food to agriculture and industry, where industrial revolution considered as a turning stage, vehicles and machines became a basic need after this period. In recent times, the internet and mobile communications became basic needs in developed societies as well. Privacy has been regarded as a basic need as well.

Abraham Maslow has presented his psychological theory of human motivation in psychological review, where he classified human needs into five levels, privacy had been included in safety category (Maslow.A.H, 1943) (see figure 4.1).

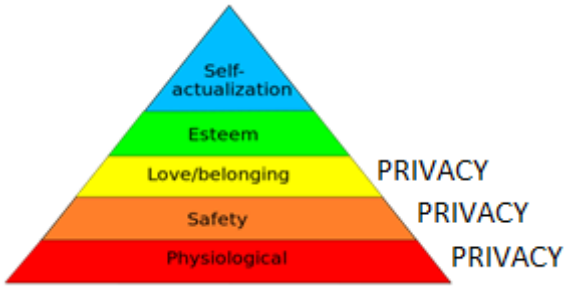


Figure (4.1) "Maslow's Hierarchy of Needs" (Maslow 1976).
Some basic needs are directly related to privacy(author)

According to Stewart (2001), privacy assists to emphasize the interaction between spaces within the same living space or between the house and the outside environment. For Altman (1975), the process of interpersonal boundary-control is being represented by privacy where, this process organizes our social interaction and separates between limiting of personal boundaries and being part of society by controlling the degree of openness and closeness or accessibility and inaccessibility.

Other scholars such as Rapaport pointed that privacy is the ability of controlling social and cultural interactions between various and different social groups and being responsible for achieving the desired and required level of interaction.

Therefore, to achieve a perfect assessment of privacy in the built environment study present a broader explanation of privacy. Then, privacy is a process of controlling personal space and social interaction between individuals and ambient social and built environment, where, privacy works as an organizer for the degree of this interaction. The less social interaction, the more private is, and the more social interaction, the less private is.

4.3. Privacy in Muslim Homes

The relationship between privacy and home had been discussed by several studies, where Rybczynski (1987) proposed that home is as a symbolic place that provides levels of domesticity and well-being through intimacy and privacy. This relationship and according to Altman and Cherms (1984) is being influenced by macro-level factors such as climate, culture, religion and socio-economic, while on the micro-level the combination of resident and privacy is affected by culture, traditions, home design, domestic behavior and space utilization.

It is well known that Arab-Muslim societies have lived as mobile tribes and they built tents to be their homes, privacy was taken into consideration in Arab tents design where it is consists of guests and visitors space, kitchen space and family space, these spaces were divided by curtains (Figure 4.2).

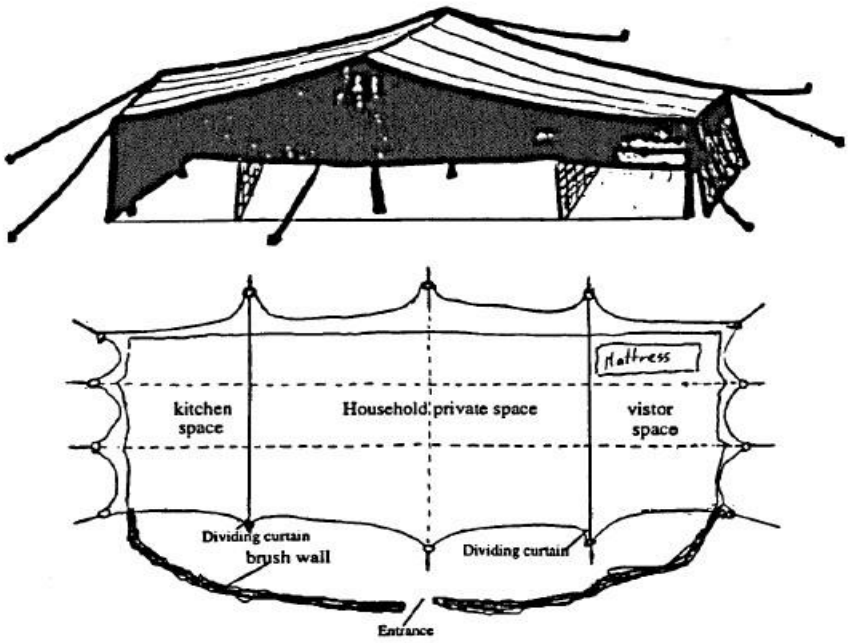


Figure (4.2) Arab-Muslim Nomads Tent and its Spaces, Source (Shawesh 1996).

Islam has been transported from Arabian Peninsula to North Africa, Turkey, Iran and Asia. Muslims who moved to these new regions have built their homes to the new religion teachings where the courtyard Arab-Muslim house became the common architectural style.

In Muslim traditional residents there more than one entrance, spaces for male guests, family spaces and sometimes female guests places. These dwellings are characterized by the separation between indoor and outdoor environment, between foreign guests or visitors and family members and between genders.

Thus, the architecture of Arab-Muslim traditional houses has been influenced in terms of privacy by socio-cultural and religious factors. (Figures 4.3.a, Figure 4.3.b)

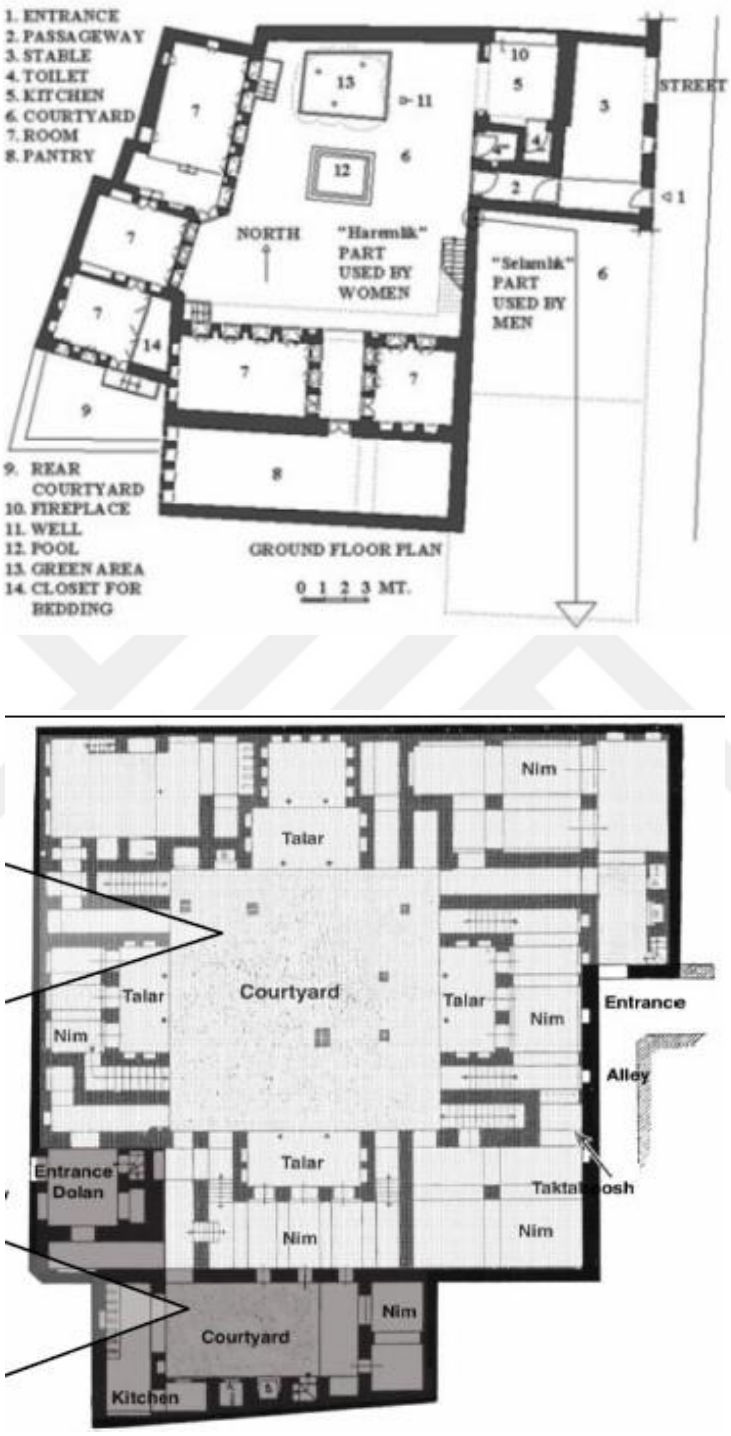


Figure (4.3.a. and 4.3.b.) Traditional Muslim Courtyard Houses.

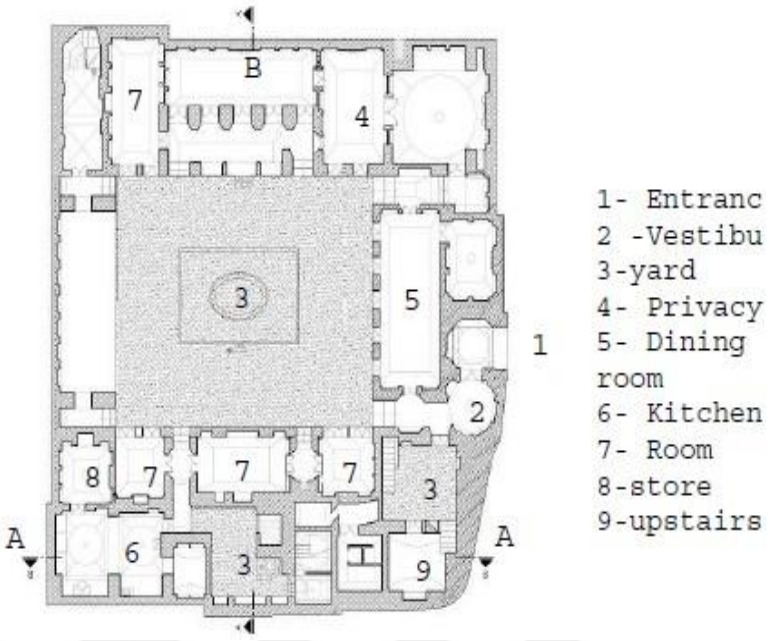


Figure (4.3.c.) Traditional Muslim Courtyard Houses.

4.3.1. Socio-Cultural Factor and Privacy in Muslim Houses

Around the whole globe every society has developed through history and created its own culture. As Ember (1981) has explained that every society has a culture, No matter how simple this culture might be, people tend to feel strongly that their own cultural components are the correct ones. Each of us is born into a specific complex culture which strongly influences how we behave and live for the remainder of our lives.

Several scholars have presented a definition of culture. Rapaport (1977) pointed that the relationship between culture and environment shows the value system of people, attitudes, preferences and environmental conditions. Whereas Lang (1987) presented that "*our attitudes and beliefs toward other society, the ambient environment, our roles in society, and the way we carry out daily activities are all components of our culture*".

Rapoport (1977), had defined the components of culture of each society into language, traditions and behaviors, these cultural values reflect ideals and create the life style are learned and transferred from period to another and from generation to another.

Despite its socio-cultural values have influenced by globalization or modernity, Privacy in Muslim societies (especially visual privacy) as a socio- cultural and religious values has been taken into consideration in house design and daily lifestyle and transmitted from generation to another. In the present time privacy still a main feature in residences design in Muslim houses.

4.3.2. Religious Factor and Privacy in Muslim Houses

Religion is being considered as the main organizer of social life where it organizes the relationships between society, family and individuals. Several scholars have defined religion in different field. Horton (1966) highlighted that "religion is an extension of the field of people's social relationships beyond the confines of human society", for Greetz (1960) religion is the system of orders which act to establish strong, pervasive and long lasting moods and motivations and to the shaping of thoughts which has led to create an aura of factuality, that causes forms and motivations to seem uniquely realistic.

In terms of the relationship between religion and built environment, Rapoport (1969) has pointed that "in some cultures, a person thrown from his dwelling was separated from his religion", which means that religion influences the form, plans, spatial arrangement, openings and house orientation where every owner builds his or her house according to his or her religious roles. In other words religion has a major effect on spaces organization within house layout.

The principles of home regulations in Muslim societies are derived from Shariaa laws that are taken from the Quran (revelation of Allah to prophet Mohamed) as well as Hadiths and Sunnahs (reported speech and behaviours of prophet Mohamed). The next main principles of privacy are extracted from these guidelines (Othman 2014, Omar 2010, Mortada 2011):-

1- Privacy: House is being considered as family's shelter and private space for family members (personal spaces).

2- Modesty: A dwelling is built by lower value in design through economical and sustainable properties.

3- Hospitality:A home is provided with spaces for receiving guests, friends, neighbours, and relatives to enhance relationships within the society.

There are several important macro-level factors that are affecting on shaping individuals perception of home privacy such as, climate culture, religion, and socioeconomic. This led to form the relationship between individuals and space utilization, and behaviours, and thus influence home design (Omer 2010).

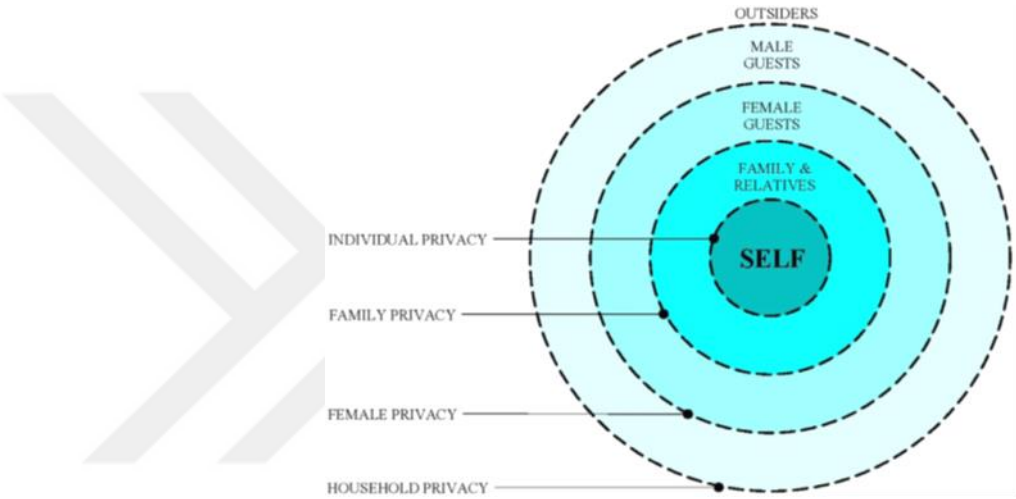


Figure (4.4) Privacy Layers in Muslim House (Bahmmam, 1987).

According to previous classification, Muslim family house could divided in terms of privacy degree into three main parts:-

1- Very private (intimate) spaces: Include kids and master bedrooms
2- Private spaces: Spaces are occupied by family members (personal spaces) Include living spaces, bathrooms, kitchens and courtyards.
3- Semi private spaces: Include entrances areas, visitors' spaces, guest rooms and storage rooms.
4- Public spaces: Streets and squares.

Then, spatial organization of Muslim houses and cities are strongly influenced by privacy requirements.

4.4. Built Environment and Privacy

Rapoport (1976) mentioned that one of the functions of the environment is to preserve self-identify, while Westin pointed that physical elements is used by designers to reinforce the psychological functions of privacy.

Heathcote (2012) proposed architectural and spatial components such as windows, doors, living spaces and bedrooms as parts that form functional organization and substantial effect on human domestic behaviors and inter actions in the indoor home environment. Regardless of the number of living and bedrooms, size of the dwelling, architectural style, or estate value, each home has to provide personal territory and meet privacy needs for its users. (Figure 4.5).

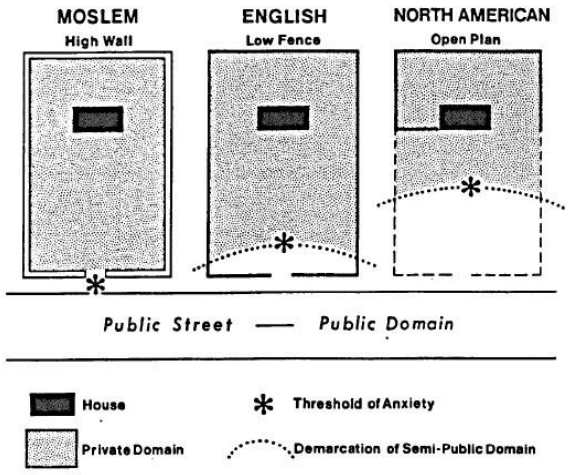


Figure (4.5) Cultural Variability in the Sanctity of the Threshold (Shawesh 1996).

In Arab –Muslim traditional cities, several physical techniques had been used to provide highest degrees of privacy, these techniques could be summarized as follows:-

a- Minimizing the openings (windows and doors).
b- Using external wooden coverage that are called (MASHRABIYAT).
c- Thick muddy or rocky walls.
d- Using middle courtyard.
e- Nondirective entrances. (Figure 4.6)

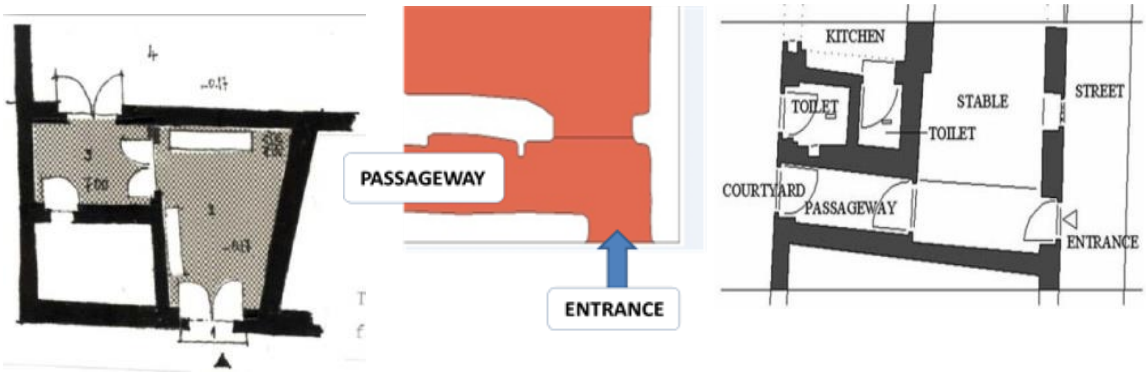


Figure (4.6) NonStraight Entrances to Control Accessibility in Traditional Muslim Houses. Cairo in Egypt, Ghadames in Libya and Diyarbakır in Turkey. (Sources Amor and Jani, the author, and Bekleyen and Dalkılıç respectively).

The mentioned above physical strategies are used to decrease the accessibility of sight and noise from outdid to inside which is undesired in Islamic teachings. According to this, privacy could be classified into visual and acoustic privacy (the seen and the heard). Then, in different cultures and locations physical environment has been designed and built to meet privacy needs which are classified into two types:-

4.4.1. Visual privacy and Gender Segregation

According to the previous discussion, in Islamic culture it is well known that the family members (especially female members) are the main concern in visual privacy issue. Particularly keeping females out of sight of foreign males.

There are several Qur"anic verses encourage segregation between family members and foreign visitors such as "*O ye who believe! Enter not houses other than your own, is an order for users to maintain visual privacy in the house*". The sayings of the Prohibits in *AL-Hadiths* he Saied, "*He who pulls the curtain wall and looks inside a house before he is given a permission to enter has committed a sin*." The Prophet also says, "*if a man ever steals a glance (or peeps) at you without permission, then you throw a stone at him, even if it puts out his eye; you are not counted as sinful.*" (Al-Qaradawi 1960)

The family is the major concern in visual privacy, particularly the protection of female members from the eyes of male strangers. The Qur'anic verse, In many places (i.e., Sus. 24:27–33, 58–62 and 5:13–16), the Qur'an commands on the maintaining of privacy within family members whether they are adults or children.

These teachings order parents inside the house to observe their children in terms of their behaviors, way of clothing and communication between genders. Hence, the privacy inside the dwelling must be kept and provided by the solutions in design of both public and private domains as well as keeping very private components that are considered as sacred (e.g., bedrooms) in the private space. In terms of the public part, the existence of a space for receiving and serving guests is necessary in the Muslim dwelling. This necessity is extracted from the duty of preserving strong relationships among society members, (relatives, neighbors, and friends).The guest room was placed in the front part of house and close to the main entrance to be separated from the family spaces to keep highest levels of visual and acoustical privacy the house. Although Islamic teachings highly encourage reinforcing social relationships among society members by exchanging visits, it forbids mixing between strange male visitors and the female members of family. Therefore, direct visual access between the visitors 'space (guests room) and the family is disallowed. Design treatments should be taken into consideration to prevent such accessibility and to maintain visual privacy of the family.

In Muslim traditional dwellings, this requirement was achieved by separating between public and private spaces by using a transitional space or doubling the entrances (one for male visitors and the other is for family members and female guests). According to Imam Muslim (1179), this requirement was a response not only to Qur'anic verses, but also to the Prophet's teachings of preventing an unexpected glance: "*permission is needed as a protection against glance*". The most important parts that they must be well-protected from the eyes of visitors are the bedrooms, kitchen and living room. Females used to spend most of their time in these domains, the arrangement of which in the welling layout should allow them to move freely. The sleeping spaces are regarded by Islam as sacred (very private or very intimate). The Qur'an commands say, "*O ye who believe! let those whom your right hands possess, and the (children) among you who have not come of age ask your permission (before they come to your presence), on three occasions: before morning prayer; the while ye doff your clothes for the noonday*

heat; and after the late-night prayer: these are your three times of undress: outside these times it is not wrong for you or for them to move about attending to each other." (Qur'an, Su. 24:58) This verse shape the need to increase the privacy of the sleeping spaces and their segregation from other spaces in the house. Separation in bedrooms (sleeping spaces) of boys and girls is also required.

4.4.2.Acoustical Privacy

Acoustical privacy is not less importance than the visual privacy. The Prophet says, "*On the Day of Resurrection, lead will be poured into the ears of anyone who eavesdrops on others who dislike him*." (HakimB., 1994).Therefore, procedures should be taken to reduce sound transmission from the inside to the outside and from the family members to the visitors' in guest area.

The previous *hadith* could be utilized as a role that organizes acoustical privacy of females of the family and male guest spaces where, in the public domain, strange males are received. The old dwellings of Muslims represented a high concern for acoustical privacy. For instance, in a typical old Muslim residences there were three internal domains male, female, and service spaces connected by a courtyard. This spatial arrangement of house layout provided acoustic preservation between these parts as well as from outside or ambient areas. Moreover, the thick-dense substances (i.e., stone, rock or mud bricks) and the thickness of the walls ensure a high levels of acoustical privacy. The elements (walls, roofs, and floors) of the envelope of the buildings should not allow the transmitting of the occupants" voices, especially females, to the external environment such as streets and neighbors. This principle is based on the commands of the Prophet about prohibiting of listening secretly (spying) to peoples' conversation without their knowledge.

4.4.3. Space Territory and Privacy

The relationship between personal space territory and privacy has been considered as one of the main determinants of privacy satisfaction within house environment. The scholars David and Palladino (1997) privacy could be achieved by psychological-environmental arrangements such as a changing self/other territory controlling process in which an individual or a group sometimes desires to be un-linked to others and sometimes wants to be connected with society.In another meaning, privacy is affected by the composition of person and space territory where shaping personal territory is a basic need, living in this territory for long period of time is an (isolation) while linking to others for long periods is crowding, both of these states are undesirable.

Hall (1969) classified space territory in terms of privacy degree into primary, secondary and public territories. Activities of occupants within home spaces determine whether this territory is private is private or public. Thus, space territory and activities of individual determine the privacy degree of each space within the house.

In dwelling spaces, personal activities determine whether the territory is private or public, for example state of using bathroom is private while husbands sleeping state is very private (intimate) while cocking and having lunch or dinner with family members is private whereas, receiving guests within the house is semi private activity.

4.5. Measuring Indoor Visual Privacy

The relationship between space and indoor privacy in dwellings has been studied by several scholars and researchers, Unlu (1999) has analyzed the spatial organization of Turkish house between 17^{th} and 19^{th} by using A Graph analysis. Other researchers such as, W.Robinson studied the space territory and privacy in the American house by using space syntax. For Mustafa and Hassan (2010) A Graph analysis was used to figure out the privacy degree in Iraqi house. UCL DEPTHMAP and its main parameters (visibility graph analysis and isovist graph) was used by Abdul Rahim and Hassan (2011), to measure indoor visual privacy in Malaysian house.

The mentioned methodologies result quantitative values for accessibility and visibility in houses which reflects the degree of indoor privacy.

Study attempt to use further methodologies to achieve more accurate results, these methods includes using AGRAPH software to analyze the relationship between spaces and the accessibility in houses. UCL DEPTHMAP is another software that is used to analyze the visuality and-or visibility (isovist parameter) inside samples.

4.5.1.Space Syntax Analysis and Privacy

During the Last twenty years, space syntax has been presented as a new computerized language to analyze spatial patterns of modern cities (Hillier and Hanson 1984, Hillier 1996). The concept of syntax is extracted from space analysis that refers to the relations between various spaces, or interactions between space and ambient environment. These principles emphasize the idea that spatial configuration (organization or arrangement) or special structure has great influence on users' social behaviors. From its roots in urban studies, space syntax suggests alanguage of space that interests for many scientific fields and application areas involved in the description and analysis of spatial patterns in the urban developments. Through the structural analysis of an urban environment, urban designers can figure out a better understanding of the development of urban spaces, and gain more ideas to help with the design of modern urban plans. Using space syntax measurements, human activities patterns in the urban texture can be studied and analyzed basically by considering the level to which urban spaces are connected and integrated. Typical applications and measurements of space syntax analyze pedestrian movement modeling, criminal activities mapping, way-finding processes in a compact built environments (Hillier 1993).

Therefore, all of these studies tend to be based on the suggestion that spatial configurations or structures have a major influence on human actions and behaviors in urban environments. Many field studies have analyzed the role of space syntax in the modeling and understanding of urban patterns and structures (Hillier 1993).

In terms of space types in the urban environment there are two types of spaces, large- and small-scale spaces. Large-scale space is not recognizable it is beyond human perception and cannot be understood from a single vantage point; while small-scale space is understandable it could be larger than the human size, but it could be understood from a single vantage point. In a linked analysis, study illustrated how the concepts of large and small-scale spaces provide modeling fundamentals for space syntax principles (Jiang et al. 2000). Urban space in large-scale could be divided into a limited number of small-scale spaces. Using such a process helps in measuring the degree of integration or\and interconnection between spaces within the structure.

4.5.2. Space Configuration and Privacy Degree

The perfect design of home should meet privacy requirements by providing the safety of family and separating the private life from public interactions (Memarians 2011). Privacy requirements include monitoring of visibility by visual privacy, and noise transmission through acoustic privacy (Mortada 2011). Thus, visibility is the ability of sight to access places. In normal circumstances, it is property to see things around us. However, in home environment it is considered as intervention that influences negatively on privacy. By another meaning, the relationship between privacy and visibility or visuality is an inverse relationship.

"*The most widespread opinion about space is that the spatial organization is an indicator of the common attitudes and the hierarchy of their different levels."* (Hillier, B., Hanson, J., 1984).The combination of individual, space and privacy form the relationship between person and the ambient environment. Privacy could be considered as the regulator of the intervention between once self, others, and the environmental stimuli (Pederson, 1997. Newell, 1998).

According to Hillier (1999) spatial configuration affects how occupants find their way in the building and spatial activity (behaviour) of any person. Ordering of space is the purpose of building, not the physical object itself. Therefore, house is not just an object, but a structural system of spaces that distributed according to users desire and the relationship between spaces are controlled by occupants' activities and social roles.

Then, space configuration (spatial configuration) (Figure 4.7.) is a main determinant of relation between person and space which is appropriated in the processes by which buildings are transformed from physical objects to social and cultural objects. In both senses, society acquires a specific and understandable spatial order (Hillier and Hanson, 1989).

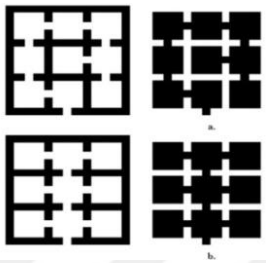


Figure (4.7) Space and Spatial Configuration. (Source: Hillier,1996)

Through history, the need for privacy had been considered as a major factor that affected the traditional houses layouts. Where, occupants built their houses to create more private and well protected environment from external intervention which influences negatively on house quality. The way of distributing spaces within houses depends on cultural and behavioural determinants, for example, the space hierarchy of traditional Muslim house in Libya is different from traditional Roman house. This differentiation is referred to cultural and religious differences.

Due to the appearance of new mechanics and concrete materials, mass production of housing projects have occurred in last century and produced new houses that are totally different from traditional houses, this had led to changing in the relationship between space configuration and privacy satisfaction.

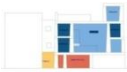
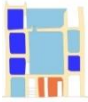
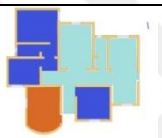
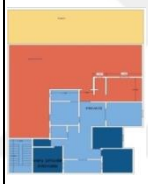
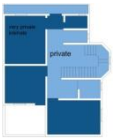
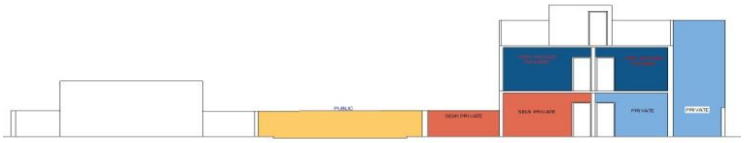
It is obvious that the spatial configuration of traditional house layout in terms of indoor privacy is depending on separating family (especially females) from the external intervention by the following techniques:-

a- Isolating the entrances and shorting accessibility.

b- Dividing the house into three floors (semi private in ground floor, private and very private in the second floor and private in top floor which is occupied by only females).

c- Separating bedrooms (girls and boys).

Table (4.1) Space Configuration and Privacy Degree within Samples (by author).

SAMPLE	GROUND FLOOR	FIRST FLOOR	TOP FLOOR	SECTION
H1				
H2				
H3				
H4				
H5				
H6	 			

PUBLIC	**SEMI PRIVATE**	**PRIVATE**	**VERY PRIVATE (INTIMATE)**

4.5.3. Spaces Hierarchy (Space Sequence) and Privacy Degree (Table 4.1)

The relationship between spaces and the hierarchy of spaces have been studied by many scholars, who pointed that the juxtaposition and the sequence of spaces are the determinant factors in privacy regulation. Private places within houses are created to be more segregated (bedrooms, kitchen, and family spaces) and to provide more privacy, secrecy, concealment and separating from the public intervention, which contents visual, aural and accessibility restriction. Whereas, public spaces are referred to living areas that are used by public such as gardens, football stadiums, theatres and squares where social activities and social integration take a place. These activities are allowed with unrestricted visibility. Public spaces basically are controlled by males and could identified by the absence of women (Chowdhury, 1992). In contrast to public spaces, private areas are usually dominated by females (Mernissi, 1987).

Hank Lu has classified the spatial configuration in terms of privacy into (Figure 4.8):

a- Public (street, garden and sidewalk).

b- Semi-public (the front yard).

c- Semi-private (the porch).

d- Private (living room, dining room and kitchen).

e- Semi-intimate (sitting room and bedrooms).

f- Intimate (master bedroom).

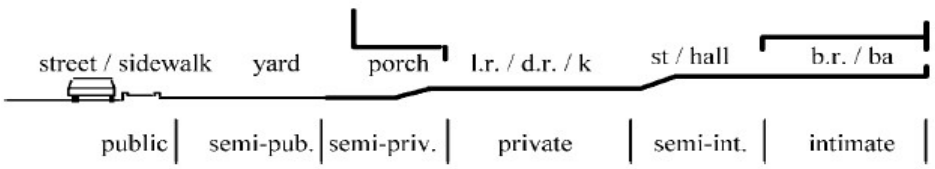


Figure (4.8) Privacy Degrees in House (source Hank Lu,2001).

While Shwashi (1993) classified spaces within Muslim houses in terms of privacy into four domains:-

a- Private (intimate).
b- Semi-private (for family members).
c- Semi-public (for family members and guests).
d- Public.

The previous classifications divide Muslim house contents into family members' spaces (private and semi-private domain) and outsiders spaces (semi-public and public domain).

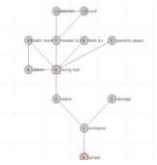
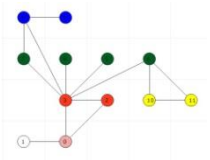
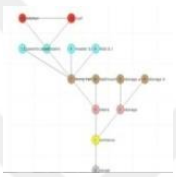
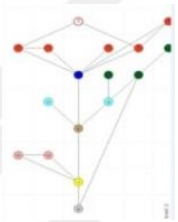
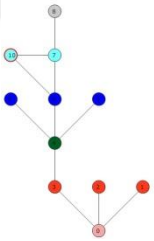
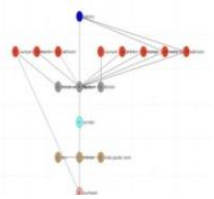
The most common view about space is that spatial configuration is an indication of the prevalent attitudes and the hierarchy of their different levels (Hillier and Hanson, 1988). In the context of space configuration, morphology deals with access between rooms, the relationship between spaces, and the diagrams of these relationships (Hanson, 2001, 2003). The main focus is to link between connected spaces and disconnect between split spaces within a group of spaces. These schemes of relationships between interior spaces shape the "permeability" system within the dwelling. According to Hillier and Hanson's analysis method (Hillier and Hanson, 1988), the morphological features of a design layout are analyzed with the help of graphs called "justified access graphs." In these graphs, all components of the plan are spaces that specify depth values according to a chosen space named "the carrier." The carrier space in the analysis is the outside of the building which is often is referred to main front entrance. According to their depth values, all the spaces are located on a horizontal line numbered with the depth of that space. All the spaces (nodes) that have the same depth values are located on the same line.

After finishing the graphs, the analysis gives few numeric measurements which are referred to the features of spatial arrangement. These measurements are mean depth (MD) of spaces within the spatial system (house layout), and the integration value of space (relative asymmetry (RA). These values have a great role in investigating indoor privacy degree of interior components. The integration and permeability are affective factors of how ''busy'' or how ''quiet'' a space will be (Hanson, 2003). Spaces are often linked to each other in patterns that are differ in terms of the distribution of integration throughout the system, some spaces of a building are more accessible (public spaces) than others (private spaces). The morphological features of a house

layout could be specified with these terms according to numerical values: symmetric-asymmetric, and distributed/non-distributed. These properties are related to the permeability and depth of the spatial configuration. Symmetry/Asymmetry represents the relative depth of space in relation to the rest of spaces in the system (Hillier, 1993).The MD of each space from all other spaces in the system (house layout) is integration describes how permeable that specific space is. According to the numeric measurements, space could be known if it is private or not, where the low values mean higher integration and, the high measures mean high segregation. The depth of each space in the system is measured in the graph from the root space, where the depth of each space is specified by the number of spaces that should pass through to move from the origin (root) space to any space in the system. The least depth could be achieved if all spaces are directly linked to the original space (root space), while the highest depth is achieved when all spaces are organized in a linear hierarchy away from the root space. In the first case, space can be symmetric with respect to other spaces in the system and asymmetric in the second case (Hillier et al., 1987; Hillier and Hanson, 1988; Hillier, 2007).

Symmetry/Asymmetry is referred to the integrating/segregating (less private/more private) influences of a space on the building layout. This feature could be represented by RA, which has a range from 0 to 1. The low value points that a space tends to be integrated with the system in its entirety, and the high value shows that a space tends to be segregated from the system. Then, if it is low, the scheme has a quality of symmetry and the spaces are equal in terms of permeability control and privacy (Shoul, 1993; Sungur and Çağdaş,2003).

Table (4.2) Justify Graph and Gamma Analysis of Samples

SAMPLES	JUSTIFIED GRAPH	MD	RA	SAMPLES	JUSTIFIED GRAPH	MD	RA
H1		4.2	0.68	H4		2.27	0.25
H2		2.95	0.32			2.86	0.24
H3		3.7	0.4			2.55	0.2

Researcher is applying justify graph analysis(gamma analysis) to investigate privacy and prepare comparison between traditional and modern houses samples to figure out the impact of transformation process on privacy levels within samples layout (Table 4.2).

Gamma analysis of samples could be summarized as follows:-

The average of MD in traditional houses is 3.58

The average of MD in contemporary houses is 2.7

The average of RA in traditional houses is 0.5

The average of RA in contemporary houses is 0.23

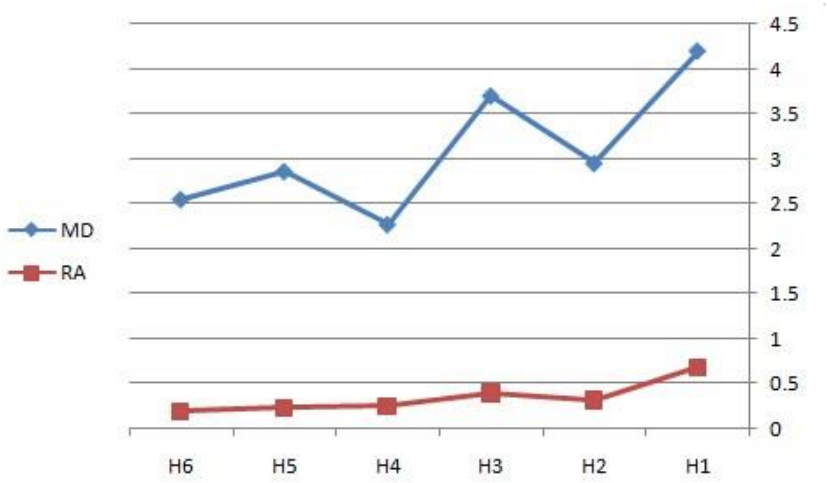


Figure (4.9) Mean Depth (MD) and Relative Asymmetry (RA) of Samples (Source, author, 2017).

From the measurements of traditional buildings layouts (H1, H2 and H3), the overall spaces are more segregated (more private and more privacy) than the overall spaces in the system of contemporary dwellings layouts (more integrated spaces/less privacy). This result is emphasized by a high mean value of (RA) of traditional samples with (0.5), which means that the spaces in the system tend to be more separated(more private/ more controlled). Modern houses (H4, H5 and H6) carry a low mean value of (RA) with (0.23), which means that the spatial configuration of this type of layouts tends to be more integrated (less private/more accessible).

4.5.4. Isovist (visual field)Measurements by UCL DEPTHMAP

UCL DEPTHMAP is a software which had been designed according to both space and time theory and space syntax theory, developed by Bill Hillier, this software analysis the relationships between urban plans elements such as spaces, streets, and the built environment. On the micro scale this software could be used to analyse the spatial analysis inside buildings and the relationships between building spaces. (Figure 4.10)

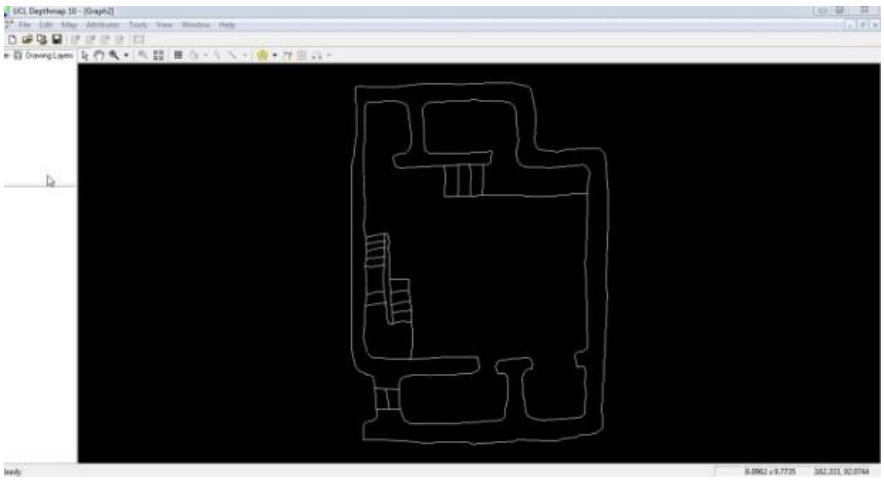


Figure (4.10) UCL Depthmap Software

Visual privacy could be measured by Isovist Area parameter.Tandy (1967) has who used isovist as a parameter to analyze landscapes and Benedikt (1979) adopts the term isovist from Tandy. The main factor in defining isovist is how far can one see or move from every point in the space. Analysis of visibility within urban landscapes (external and/or internal visibility) leads to know whether the layout visually is open or not. In buildings and streets represented as 2D polygons, rather than 3D grids, a first level of visibility analysis can be carried out – this kind of analysis is generally described as isovist analysis (Benedikt,1979). In addition, Isovist analysis has been developed in landscape studies and is integral to GIS (Rana,2002). Isovist area is defined as the exposed area within visual field in a specific point, it is measured by m^2. This parameter possibly could be used to examine visibility or visuality within house environment. It is appliedduring examining complex patterns of activities and behavior of occupants. For example, open spaces could be seen and have visibility more than closed spaces or in case of existence of obstacles. (Figure 4.11)

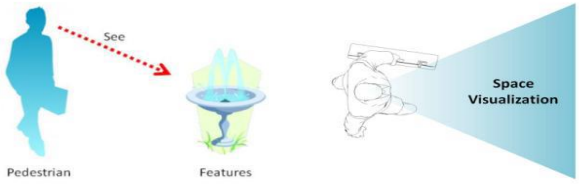


Figure (4.11) Isovist Area (visual field).

Isovist area could be measured automatically by using isovist icon in UCL DEPTHMAP software. Study would use two main reference points, first point is at entrances and second point is at the middle of the plan. After clicking on isovist icon and specifying location of the center of the isovist the program would ask the user to choose the angle of visual field (90 degrees, 120 degrees, 180 degrees or 360 degrees). By clicking on the chosen angle, the program gives the user direct plot of the visual field or the isovist. The given plot specifies whether this space is open or not, in other words this space is visually exposed or not and then this space provides desirable levels of visual privacy or not. For example, the following plan is for a room with area of 4m*4m would be used as a sample to apply isovist on it. After transferring the original autocad drawings into dxf format, plan would be imported to UCL Depthmap and then by clicking on isovist icon, program would specify the plot of visual field according to the chosen angle and place of clicking. (Figure 4.12), (Figure 4.13).

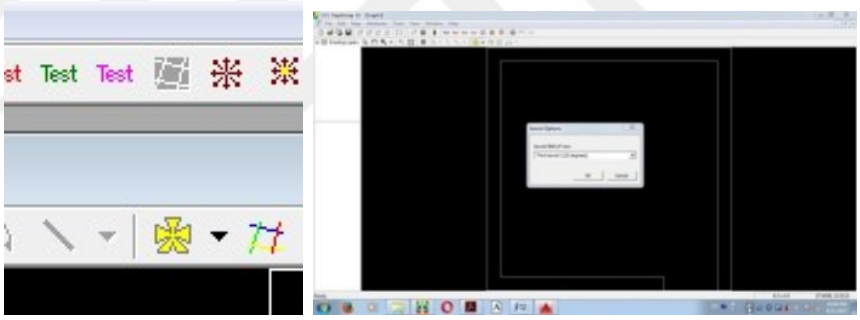


Figure (4.12) Left, Isovist Icon in UCL Depthmap. Right, Choosing the Angle of Isovist in UCL Depthmap (source, by author).

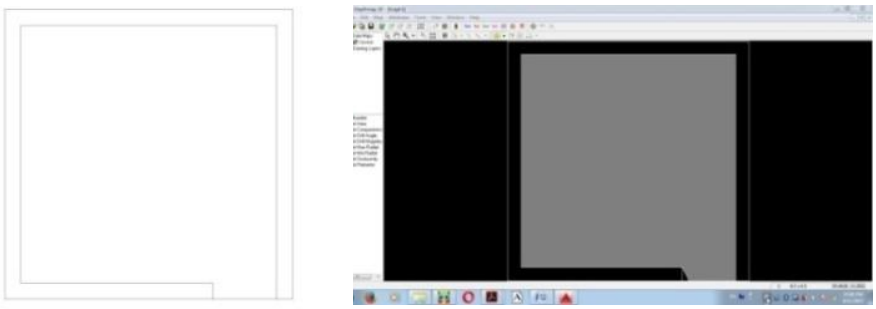


Figure (4.13) Applying Isovist in the Center of Sample Plan (Source, by author).

The previous figure shows the isovist (visual field) of the center of the room (middle) with angle of 90 degrees. It is obvious that the whole room is visually exposed unless there are barriers or obstacles. Entrances (doors) are considered as the transfer stage between public and private environments.

"The placement of the entrance doors of houses should come within the concept of preserving private life and ensure that no offence is caused to neighbors' privacy. Muslim jurists agree that these entrances should not be opened opposite to or near each other and they should be offset in order to restrain the person standing at an entrance from looking directly into the house opposite or Adjacent" (Mortada,2003). Therefore, entrances and doors must be considered as a reference point of isovist measurements (Figure 4.14).

For the previous sample, isovist field in the entrance as follows:-

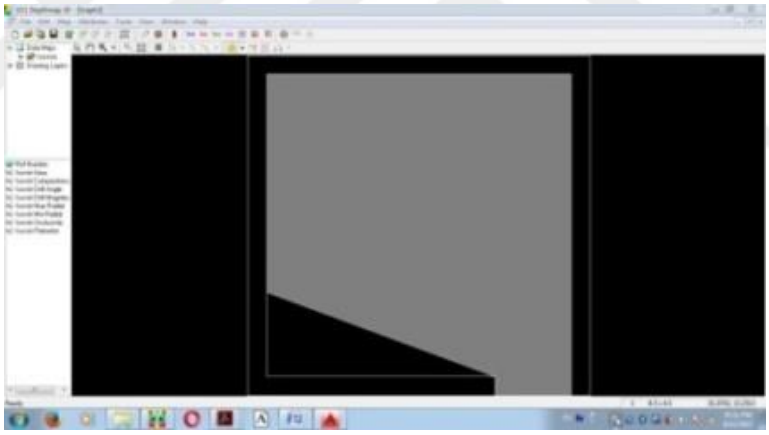


Figure (4.14) Applying Isovist in the Entrance of Sample Plan (Source, by author).

The program has ability to transfer plots to values and digits by clicking on (table) which is included in (window) icon. It was shown in Figure (4.15) Extracting Isovist Area in the Middle (left) and in Entrances (right)(Source, by author). The figures are not recognized clearly so not given in the text.

Isovist area in the middle is 16.23m^2 while the area of isovist in entrance is 14.4 m^2. These values indicate that the area of visual field in the middle of space is bigger than the area of visual field in entrance.

i. Isovist Measurements Within Houses

By comparing between spaces in traditional houses and spaces in modern samples, it is obvious that spaces in traditional samples are smaller and more isolated in terms of visibility. This is referred to the small size and dividing houses to three floors.Isovist measurements in samples are applied in two main references (entrances and middle of the plan).The previous method has been applied on study samples. Results of isovist measurements are summarized in Table (4.3) .

For more understandable results, measurements could represented in the following figures: (Figure 4.15.)

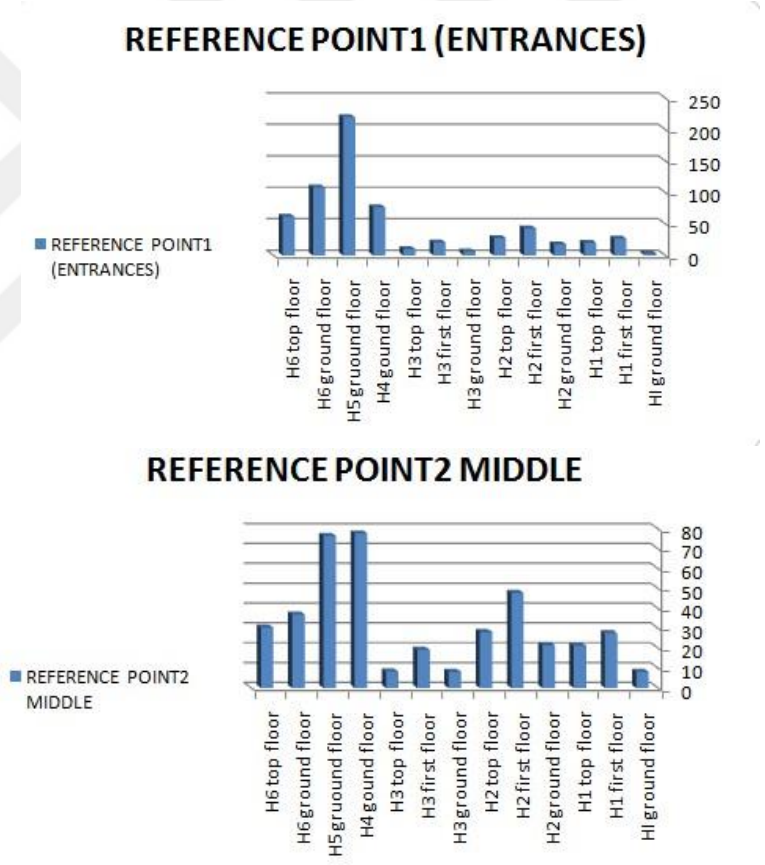
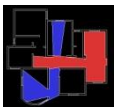
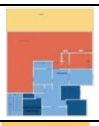


Figure (4.15) Isovist Measurements of Samples in Reference Point 1 (Entrances) and Reference Point2 (Middle).

Isovist measurements of samples generally indicate that visual field (exposed area) in (reference point1)the middle is lower than visual field in reference point2 (the middle).

Table (4.3) Isovist Measurements of Samples. (Source: by authors).

samples	plans		Isovist at Reference pointEntrances m²		Isovist at Reference point middle m²	
TRADITIONAL HOUSES	H1			3.01		8.1
				26.7		27.55
				20.2		21.029
	H2			17.65		21.57
				43.17		47.88
				27.57		28.12
	H3			6.2		8.2
				20.6		19.2
				10.3		8.3
CONTEMPORARY HOUSES	H4			76.39		77.72
	H5			219.56		76.53
	H6			107.9		37
				61.25		30.35

Visual field in contemporary samples (H4,H5, and H6) is higher than isovist area in old samples (H1, H2 and H3). That means modern houses are designed and built to be more visually exposed than traditional houses.

In traditional units and according to isovist results the most exposed area is located in first floor in living hall while the less exposed area is located in ground floor. (Figure 4.17).

Figure (4.16) Isovist Area in the Middle of First Floor in Traditional Units (samples 1and2)

Builders of old dwellings built their houses with non-straight entrance to reduce visual intervention especially between foreign visitors and family members. This strategy is not used anymore in modern houses, where main entrances in modern samples lead directly to the core of house (living room) which decreases visual privacy and influences negatively on the quality of daily lifestyle. (Figure 4.18), (Figure 4.19).

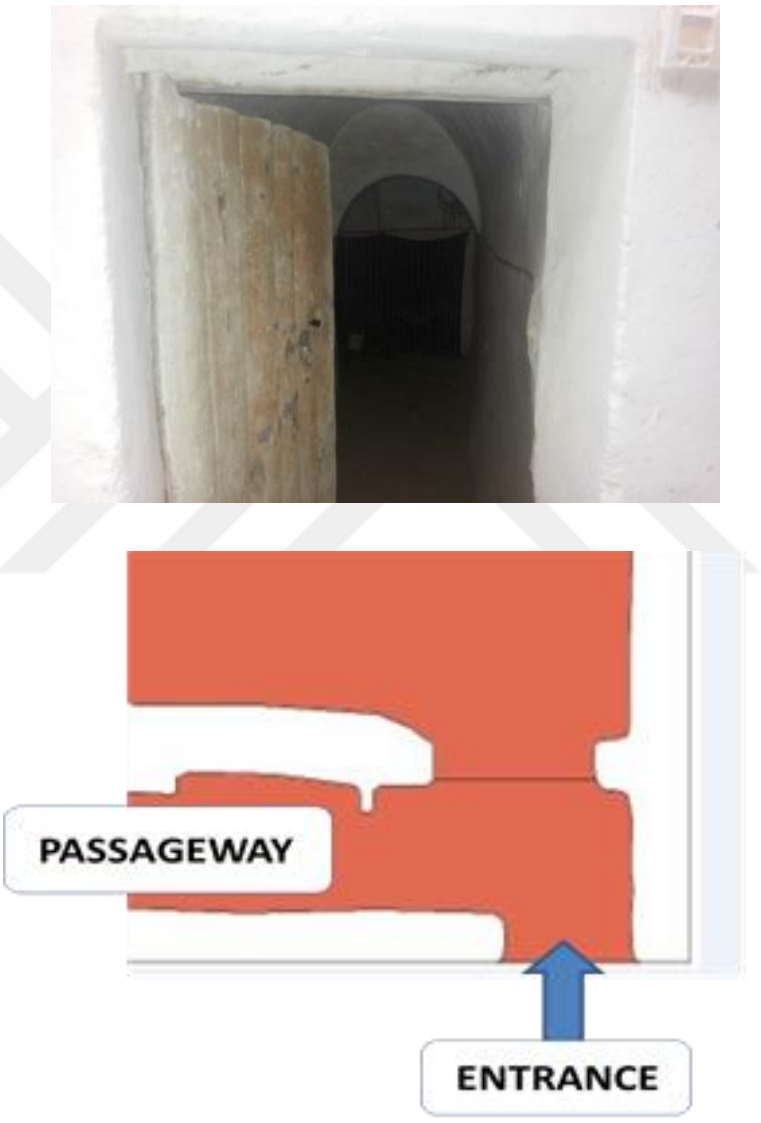


Figure (4.17) Minimizing Entrance Area to Reduce Visual Intervention between Guests and Family members.

Figure (4.18) Visual Field in Entrances of Contemporary Houses. (Sample 5).

It is obvious that entrances in traditional houses provide higher privacy than entrances in modern residents. Where family spaces in modern houses are directly linked to the main entrance which is not found in old units.

ii.Isovist Measurements in Streets

It is well known that most of traditional Arab-Muslim cities are characterized by that were built gradually in compact fabric where buildings attached to each other by thick walls and parts of city connected to each other by network of non-straight covered passages (Rapoport 2014). Ghadames in not different from this system, where each neighborhood is linked to the other by similar network of covered streets (Figure 4.20).

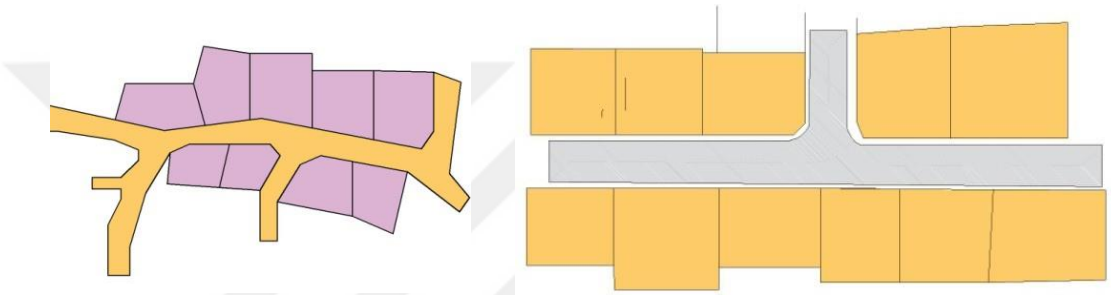
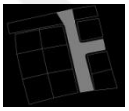


Figure (4.19) Left, Part of Traditional Street (Tasku), Right, Part of Modern Street (center district) (Source: Author).

Due to the change in life style, technology and the appearance of cars and vehicles, the urban planning of the modern part changed where streets became bigger or wider and houses became separated, this has led to create different urban planning.

To figure out the differences and similarities with modern streets in terms of visual privacy study applied isovist measurements on four samples of traditional streets and four samples of modern streets.

Table (4.4) Isovist Measurements in Streets Samples (Source: by author).

Sample (street)	Reference point (middle)	Isovist area m^2	Isovist area\ total area%	Sample (street)	Reference point (middle)	Isovist area m^2	Isovist area\ total area%
Tasku		22s.17	58%	Center district street		1165	88%
Djursan		29.02	19.73%	New district street		1590	84%
Tangzin		61.62	55.6%	South district street		2011	68.4%
Aoulad Bllel		58.34	60.28%	East district street		1330	63.8%

For more understanding, results of isovist measurements of streets could be summarized in the following figures:- (Figure 4.21).

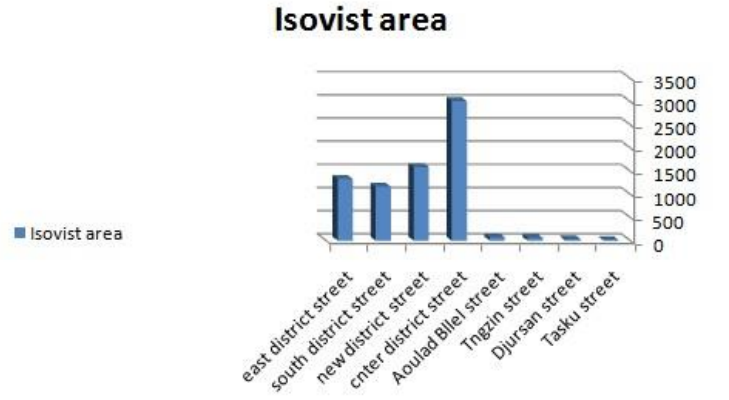


Figure (4.20) Isovist Measurements of Modern and Old Streets, (source, author).

The figure shows that streets of central district are more open while Tasku street is lowest value, that means streets of old settlement built to be less open and modern streets are exposed due to the open urban fabric (Table 4.4).

iii. Participants Response on Privacy Satisfaction

According to questionnaire results, elder dwellers and young inhabitants believe that traditional houses provide indoor visual and audio privacy more than contemporary houses do where 79% see that vernacular dwellings are more private than modern residents (see figure 4.22) while 58% think that the accessibility in modern buildings is easier than old residents. Most of designers and engineers who were interviewed referred this to the change of house design and spatial distribution of modern houses. (Figure 4.22), (Figure 4.23).

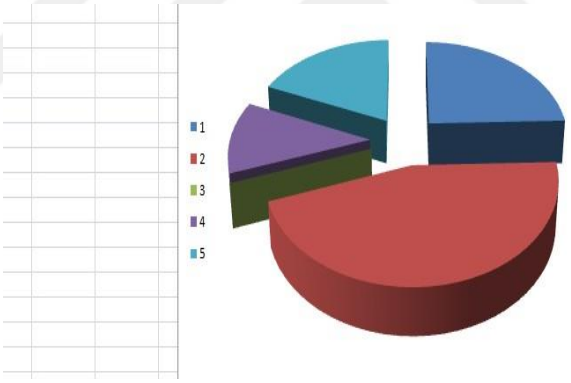


Figure (4.21) Participants Response about Privacy in Traditional and Modern Houses (by author).

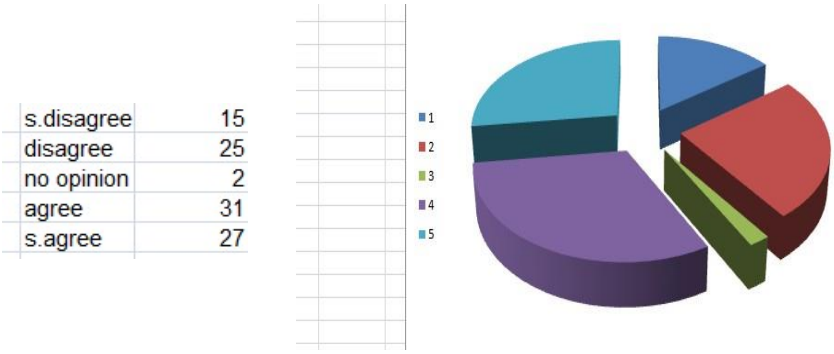


Figure (4.22) Participants Response about Accessibility in Samples (by author).

4.6. Interim Conclusion

According to the previous results, dwellers of houses consider that indoor privacy and gender segregation are crucial factors in designing the house. The spatial configuration of traditional houses was organized to separate between semi private and very private spaces and between males and females. This separation in contemporary houses is less than traditional houses, while accessibility (from outside to the core of house) in contemporary samples is easier than old samples.

Constructors of traditional residents have used several techniques to avoid visual intrusion and to increase visual privacy, these techniques could summarized as follows:-

a- Dividing dwellings into three floors, ground floor was occupied by men (males), first floor for family and top floor for women, were women are allowed to move from house to another by network of pedestrian on top roofs. While men (males) are moving in covered streets in ground floor.This character is not exist in the modern city.(Figure 4.24)

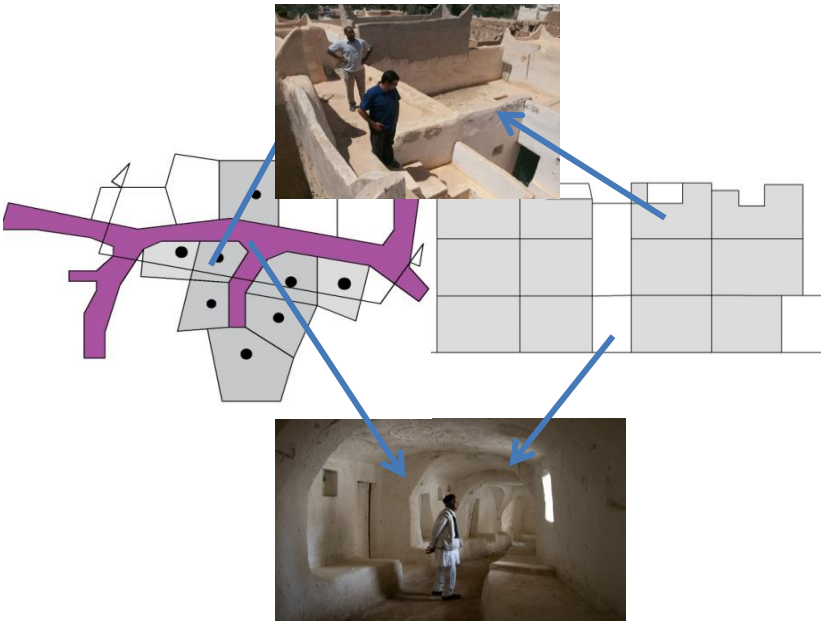


Figure (4.23) Left, Plan of Roof Passages for Women, Right Section in The Street (source, author).

b- Old occupants of traditional Ghadames have found their own way to avoid visual intrusion by minimizing visual field at the main entrance, where most of entrances with area ranges from (1.5*0.7) m to (1.7*0.8)m. most of the main entrances open directly in covered streets. Location of the main entrances is not randomly chosen. Entrances should be not be facing neighbors' entrance. While entrances in modern district are meeting each other as shown. (Figure 4.25), (Figure 4.26)

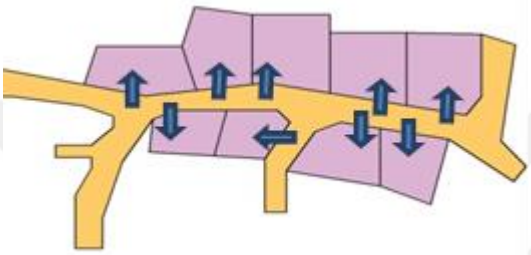


Figure (4.24) Left Distributing Entrances in Part of Tasku street, Right, Main Entrance of Traditional Sample2 (source, author).

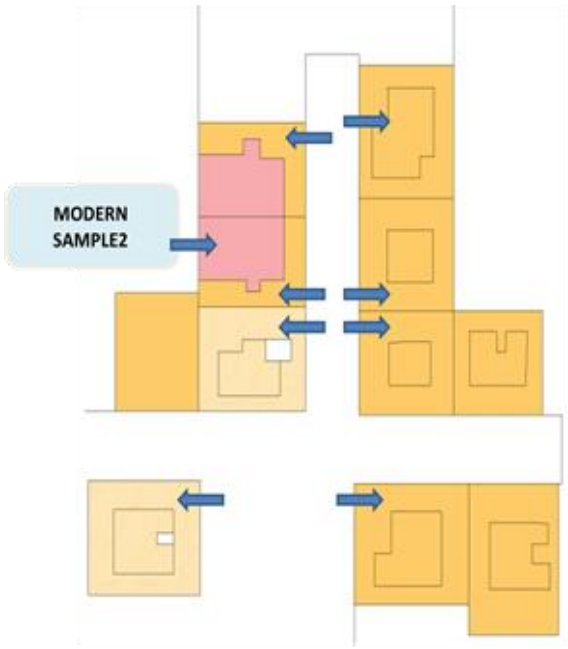


Figure (4.26) Left Distributing Entrances in Part of Modern Streets, Sample6 (source, author).

c- Minimising the size of windows of old dwellings with area of (0.4*0.4-0.6*0.6) while window of modern elevations open directly in the street with area ranges from 1*1 to 1.5*1.5 which makes the inside private spaces exposed for outsiders.

Thus, changing of house design from traditional layout to modern design caused variation in spatial configuration, spaces hierarchy, and visual privacy within house. The basics of design of modern houses have to be derived from traditional principles of old houses. For owners, design of future dwellings should be based on the architectural features of old houses. (Figure 4.27)

Traditional House Windows

Modern House windows

Figure (4.26) Minimising Windows in Traditional Houses.

5. ANALYSIS OF THE INFLUENCE OF MODERNISM ON THERMAL PERFORMANCE OF GHADAMES HOUSES

Thermal performance of buildings is referred to the process of heat transfer between the ambient environment and the physical envelope of buildings. The process of heat transfer have been taken into consideration around world where humans built their shelters to protect their bodies from harsh climate whether it is very cold such as Husky houses or hot-dry climates such as courtyard-stone houses in Mardin in Turkey where no fans, heaters or air conditioners are used.

In hot-dry environments, occupants have dealt with harsh climate conditions by constructing courtyard houses that are built by stone or mud and wood. Other strategies have been used to improve thermal response such as using MASHRABIYAT and WINDCATCHER in Iran and Arab gulf countries. In contemporary houses these strategies are not used anymore where they replaced by using electrical and mechanical means to provide thermal comfort.

In Ghadames traditional houses were built to meet over 45c temperature and over 40km sandy hot winds in summer. Therefore, the types of climates around world and the relationship between climate and thermal performance in both vernacular and modern residents in Ghadames city would be studied in this chapter to assessment the influence of modernism on desert houses in Ghadames.

5.1. Climate Types around the World

Climate scholars have studied and classified world regions according to their climate conditions, and the most common classification is KOPPEN climate map where he divided world climate map into zones each zone has the same climatic criteria.

According to KOPPEN map, climatic zones around world are:- (Figure 5.1)

a. **Rain forests:** This zone is characterized by high rainfall amount, where it ranges from 1750-2000 millimetre and 18c during of all months of the year. This climatic zone is covering different regions in the world such as, Brazil, Indonesia, Malaysia, and Cameron.

b. **Manson**: Manson is a seasonal wind that lasts for several months, it has been found in regions such as, Northern America, Southern America, Sub-Sahara in Africa, East Asia and Australia.

c. **Tropical Savannah:** Savannah is known as a huge area of grassland located in semi-arid and semi-humid regions of sub-tropical and tropical latitudes temperature in this region is about 18c in the year. Rainfall is between 750mm and 1270mm a year. This type of climates is located India, Malaysia, South Africa, Africa and Australia.

d. **Humid-subtropical:** This zone lies between 20 and 20 degree away from the equator, where large storms and thunderstorms occur in this zone.

e. **Humid Continental:** Temperature in this zone varies from over 10 to below -5, climate of this zone marked by variable weather patterns in one day.

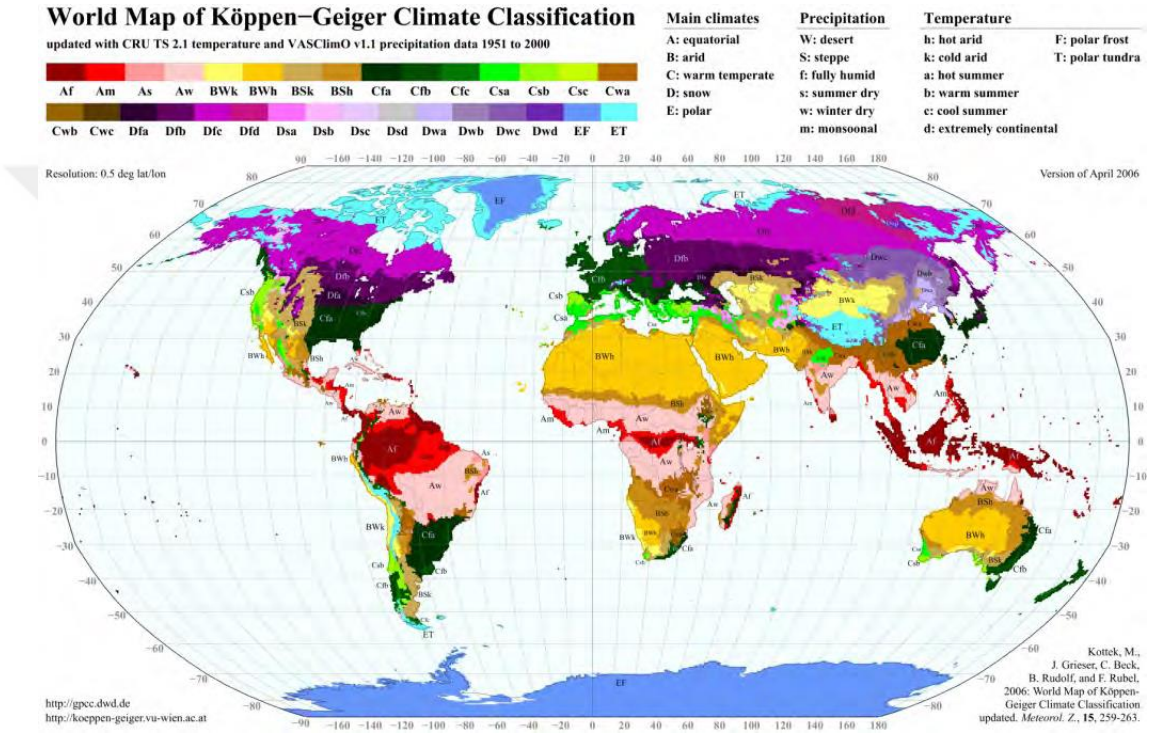
f. **Oceanic Climate:** This type of climate is located in the west coasts at the middle latitudes of all the continents and in south-eastern Australia and characterized by heavy rainfall.

g. **Mediterranean Climate:** Climate Mediterranean region covers Mediterranean basin where it is marked by hot-dry summers and cold wet winters. There are regions are having the same climatic features such as, north America, parts of south Australia, south Africa, Mediterranean countries.

h. **Sub-Articic climate:** The annual temperature in this climate ranges up to 40^0 C in summer and below -40^0 C in winter.

i. **Polar Ice Cap:** This climatic zone is located in the north and south polars of hemisphere, it is covered by ice in all year seasons.

j. Desert climate: Desert regions are scattered in different locations on earth, desert climate is characterized by hot-dry summers and cold-semidry winters, where perception is about 10mm a year, summer temperature is above 45^0C and below 0^0 C in winter and humidity is less than 50%.



Figure(5.1) The World Climate Zones Referred to Köppen-Geiger Classification Method(Kottek *et al.* 2006)

The harsh climatic conditions of desert regions are referred to long time radiation during summer days, where it achieves 17 hours a day. This amount of radiation produce huge amount of heat energy which affects directly on buildings and ambient environment. Hot winds which are carried with sand and dust increases temperature rapidly as soon as it touches buildings with speed ranges from 30-50 kmh. therefore, buildings in this climate should be designed and built with taking into consideration harsh climate conditions. The hot weather in summer or in cold winters, heat transfers into buildings and affect directly on indoor temperature and then thermal comfort.

5.2. Climatic Responsivity in Buildings

Since the beginnings of human civilization, house has been built to provide a protection from wild animals and climate conditions, in another meaning protection for survivor. During the time, daily life style has changed and human life requirements are developed to include more family activities, social activities, privacy and thermal comfort.

A resident could be considered as a climatic adapter which protects the indoor environment from the external climate. The conditions of weather that shape and define local climates are called elements of climate (Giovai.1976,chp1).

The relationship between houses and climate has been considered as a major factor in dwellings construction, therefore, to design typical or suitable house within a specific environment, it requires that designers should understand the climate conditions that effect on these house and take them in consideration.

In hot-dry regions such as, Saudi desert, Australian desert, Iranian desert and Sahara desert in middle of Africa, which covers about 80% of Libya, climate conditions play an important role in construction process where temperature achieves about 50c and about -10c in winter which is out of human body ability to adapt. These conditions impose a good understanding to climate to produce buildings with climatic responsivity. To understand the process of thermal performance study proposes explanation of heat transfer in buildings and how construction gain heat.

5.3.Thermal Comfort in Buildings

Through history human has always tried to build a comfortable shelter in terms of thermal comfort which was reflected in vernacular buildings materials and construction methods.

5.3.1. Thermal Comfort in Hot-Dry Climate

Satisfaction with the thermal environment is an important requirement for its own sake and because it influences on productivity and health. Office workers who are satisfied with their thermal environment are more productive (Huizenga and others, 2006). The phenomenon of thermal comfort is referred to the sensitivity of human body to temperature, humidity and wind speed. In cold regions human body should be well protected from cold air currents and low temperature while in hot humid climates buildings should provide speedy air currents to reduce the influence of humidity.

According to the International Standard ISO 7730, thermal comfort is explainedas: 'that state of human mind which represents satisfaction with the thermal environment.' In ASHREA55 standards thermal comfort in hot-dry climate could be presented in the following figure:- (Figure 5.2)

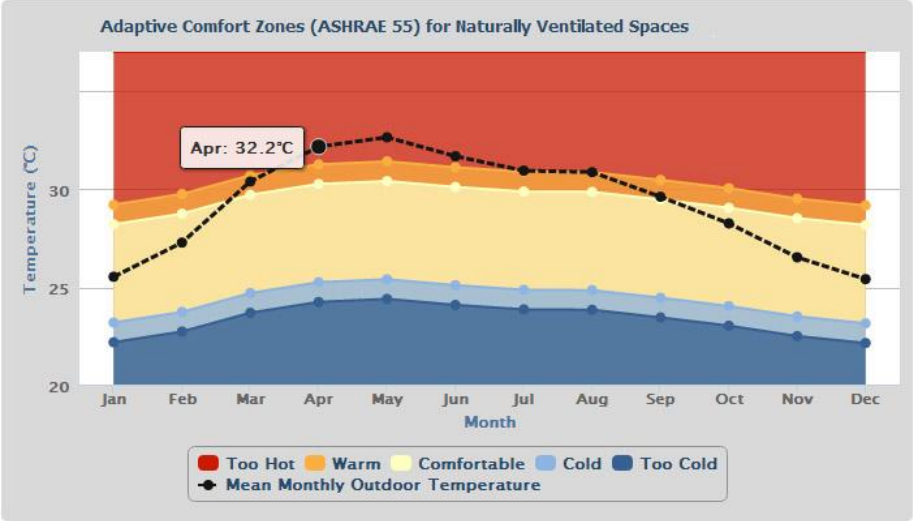


Figure (5.2) Adaptive Thermal Comfort Zone (ASHRAE55).

It is obvious that the thermal comfort temperature ranges from 23c to28c in January and December (winter season) where the peak temperature ranges from 25c to 31c in May and June (summer season). Then, thermal comfort is a compensation that consists of human body and climate conditions such as temperature, humidity, wind speed and vapor pressure (Fanger, 1973). Thus, the study proposes measuring these thermal data and prepare a comparison between samples to figure out to what extent modernization affected the thermal performance of buildings.

5.3.2. Air Temperature and Thermal Comfort

In biology, the relationship between human body and thermal comfort ranges between comfort to pain and then death. The following table summarizes the relationship between temperature and human body. (Table 5.1)

Table (5.1) An Influence of Temperature on Human Body
(Source Auliciems and Szokolay, 2007).

Skin temperature	Deep body temperature	Regulatory zone
pain: 45°C	42°C	death
	40°C	hyperthermia evaporative zone vasodilation
31- 34°C	37°C	comfort vasoconstriction thermogenesis
	35°C	hypothermia
pain: 10°C	25°C	death

If indoor temperature in dwellings rises above 37^0 C the human body becomes warmer which causes damages such as hyperthermia and causes death if temperature is 42^0C or more. Therefore, home environment should provide reasonable averages of temperature to avoid undesirable thermal state.

To figure out the state of indoor temperature and the impact of differentiation in terms of indoor temperature between traditional buildings and modern dwellings, study suggested preparing temperature measurements of samples. The strategy of field survey of temperature depends on measuring indoor and outdoor temperature for each sample in two hours begin from 8 morning to 2 at night by using digital thermometer.

Figure (5.3) Field Measurement of Temperature in Samples (source, author, 2017) .

The field measurements of temperature of old houses could be summarized in the following figure:- (Figure 5.3, Figure 5.4, Figure 5.5)

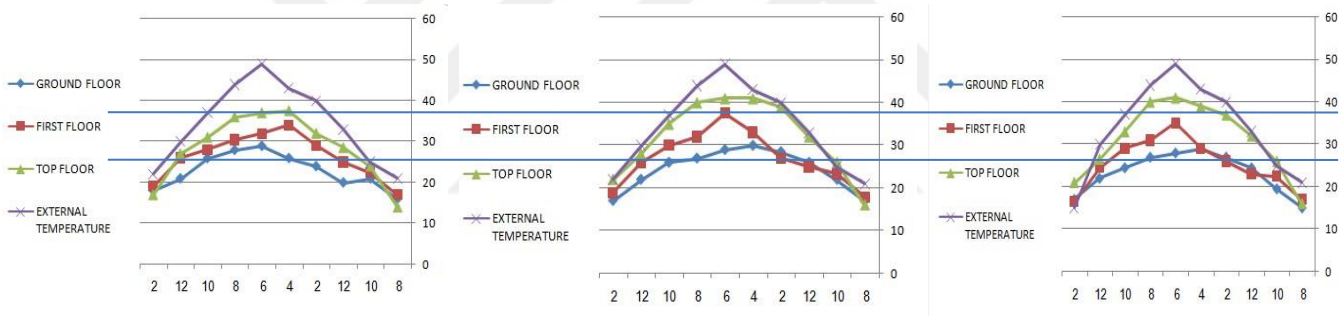


Figure (5.4) Indoor and Outdoor temperature in Traditional Houses.

While measures temperature in modern samples is presented in the following figure.

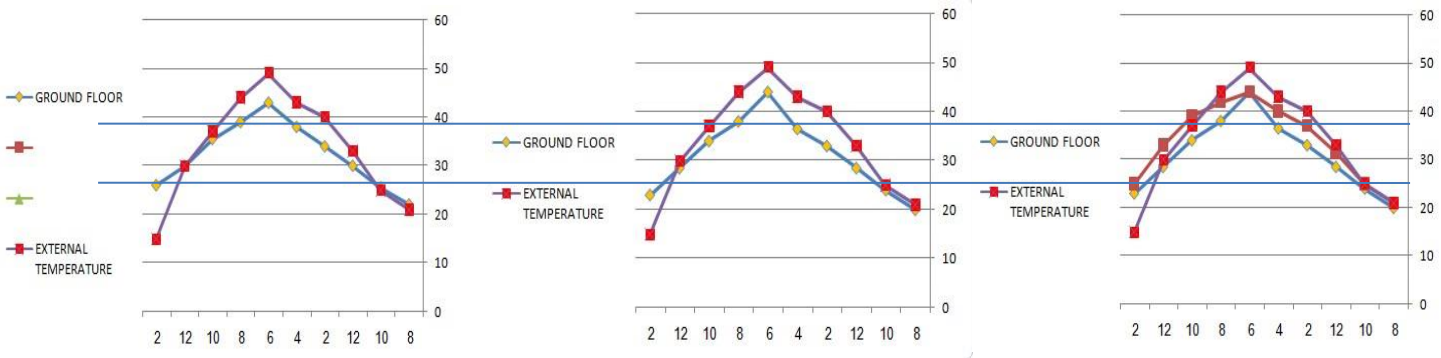


Figure (5.5) Indoor and Outdoor Temperature in Contemporary Houses.

For easier understanding, maximum and minimum temperature in samples could be summarized in the following figure: (Figure 5.6)

Figure (5.6) Indoor and Outdoor Temperature in Samples (Source, author).

As mentioned previously, one of the most outstanding features of desert climate in Ghadames is the high temperature at day where it reaches about 50^0C as well as low temperature at night where it decrease to about 10^0C. From the field measurements, outdoor peak temperature takes a place at 4pm where it reaches 49c.

At that moment, the maximum indoor temperature is at contemporary house3 (H6) and contemporary house2 (H5) with 46^0 C and 44^0 C respectively. However, the lower temperature was measured in ground floor of traditional samples H3 where it reached 16^0 C. This is referred to that the compact urban fabric makes ground floor well protected from the direct sunlight and ambient temperature.

Figure (5.7) Max and Min Indoor Temperature in Samples

5.3.3. Relative Humidity and Thermal Comfort

According to ASHREA standards 55 relative humidity (RH) in hot dry climates is lower than 20-30%. This value is uncomfortable dueto its effect on the mucous membranes. The required value of indoor humidity is ranging between 30% and 60% (ASHREA55). Therefore, in desert regions dwellings should provide desirable levels of indoor relative humidity. Because of the lack of water vapour in the air, hot-arid climate zones witnessed low values of relative humidity. The Meteorological Office records point that annual relative humidity in Ghadames range from 53-52% in December and January (winter months) while it fall to about 20% in June and July (summer months). (Figure 5.8), (Figure 5.9)

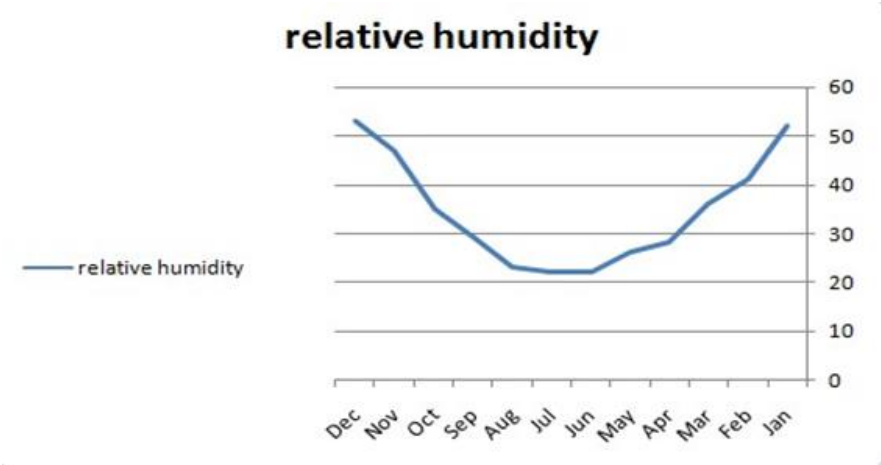


Figure (5.8) Annual Relative Humidity in Ghadames (Source Meteorological Office).

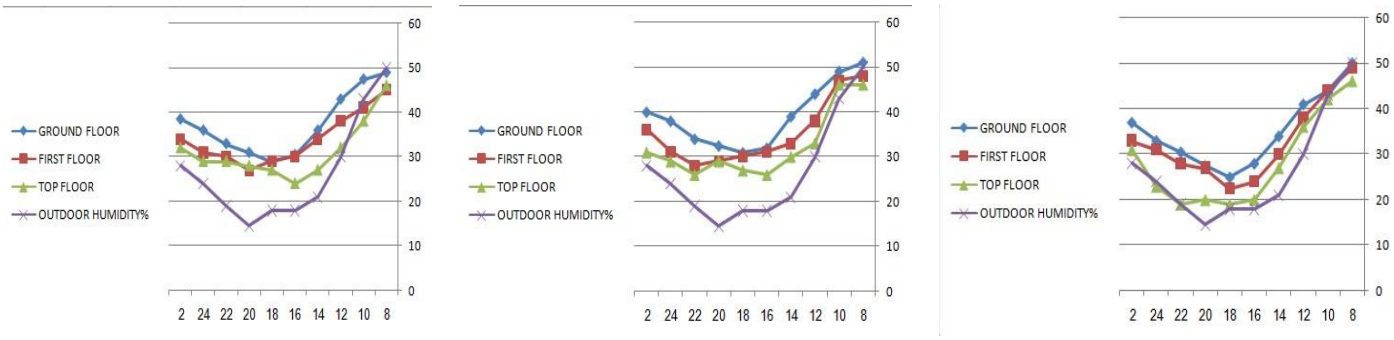


Figure (5.9) Relative Humidity in Traditional Houses.

Humidity in traditional houses in Ghadames fluctuates from 22% to 25% which is close to the comfortable levels.

Humidity measurements indicate that the lowest value of humidity takes a place at 6 o'clock afternoon while the highest value in ground floor. This means that ground floors in old houses are able to store acceptable levels of humidity which makes them the most comfortable spaces in terms of thermal comfort.

The highest levels of humidity are in the ground floor in storage room in old house H3. While the lowest values are in contemporary sample H5. (Figure 5.10)

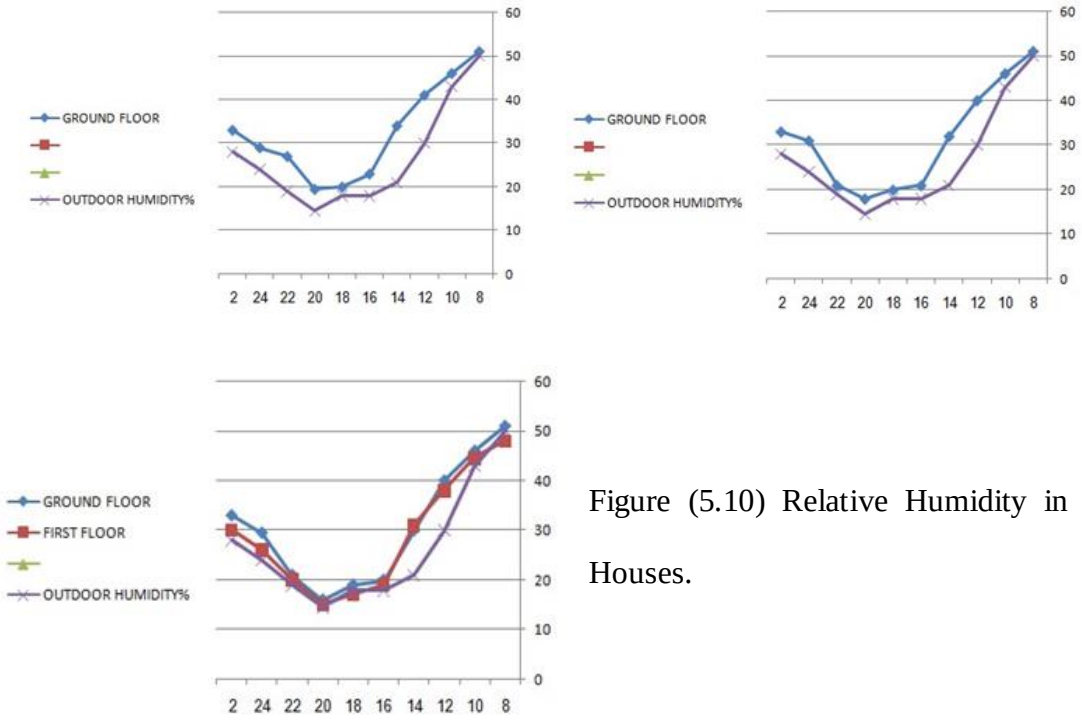


Figure (5.10) Relative Humidity in Modern Houses.

In one-floor contemporary houses the humidity is affected by the rapid increase in temperature, where as soon as ambient temperature rises it works on evaporating water in air which leads to undesired thermal state. At night humidity levels increase to achieve about 50% while it falls to about 15% at16pm. By comparison, traditional houses store humidity more than modern dwellings while contemporary constructions lose humidity faster. This makes vernacular houses thermally behave better than modern homes. This explains why dwellers of modern buildings are completely depending on electrical air conditioner units to provide thermal comfort. (Figure 5.11 and 5.12)

Figure (5.11) Left, Maximum Relative Humidity in Sample3, Right, Minimum Relative Humidity in Sample5 .

Figure (5.12) Using Electrical Air Conditioner in Contemporary Houses.

The following chapters/paragraphs discussed the responses of the questionnaire respondents.

5.3.4. Participants Opinion About Thermal Comfort

97% of contributors believe that contemporary concrete houses are not able to provide thermal comfort without using electrical or mechanical means. This explains why most of Ghadames occupants are depending on electrical air conditioners in most of modern houses. (Figure 5.13)

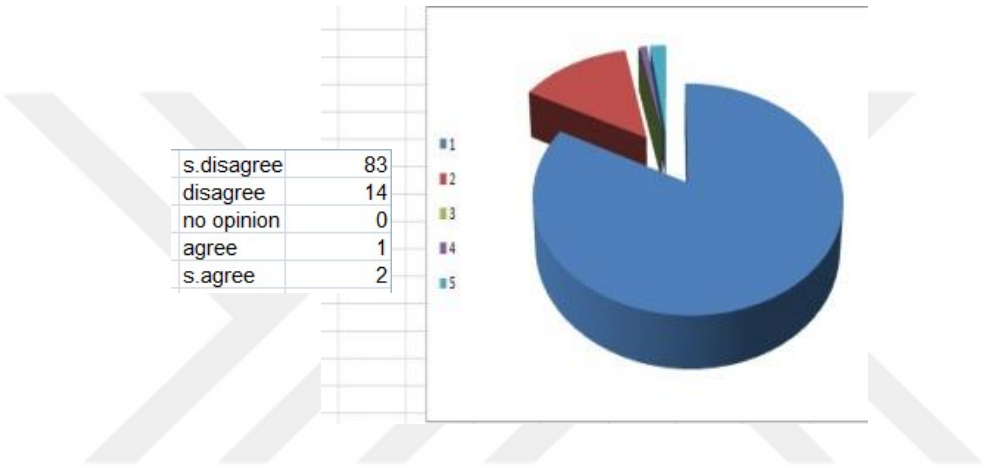


Figure (5.13) Participants Opinion about Thermal Performance in Modern Houses.

It is obvious that modern concrete residences gain heat faster than old-muddy houses while vernacular buildings keep cool temperature and suitable humidity.

The question now why traditional buildings thermally behave better than modern concrete buildings. To answer this question, this proposes physical explanation of heat transfer process between buildings envelope and ambient environment.

5.4. Heat Transfer through Buildings

Heat transfer is an exchange process between buildings and the ambient environment temperature, whether temperature in cold climate or hot climates, flows into buildings by three ways of transforming. Heat transfers through buildings by three main methods, radiation, conduction and convection (Figure 5.14)

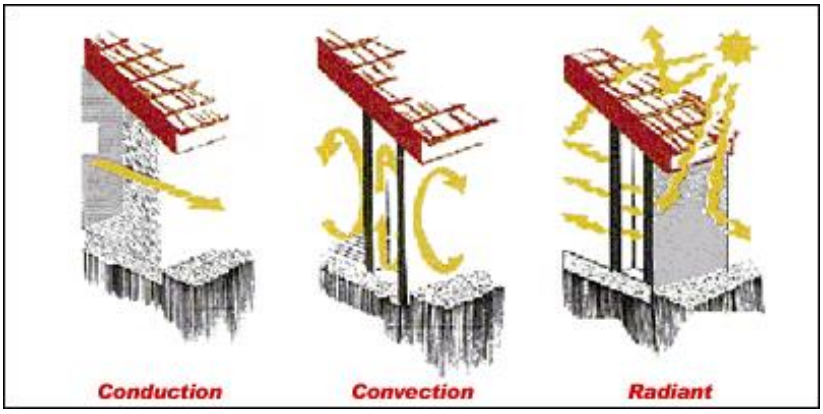


Figure (5.14) Heat transfer Through Buildings.

5.4.1. **Radiation** (Figure 5.15)

The main source of heat in external environment is sun radiation, as soon as it touches the external parts of building heat begins flowing into this surface. Emitted heat will be absorbed by this surface.

In buildings the external envelope is consisted of, walls, roofs and openings, these elements are exposed to the direct sun radiation, these elements play a major role in heat transfer by radiation, therefore, such as elements should be designed according to the heat transfer calculations.

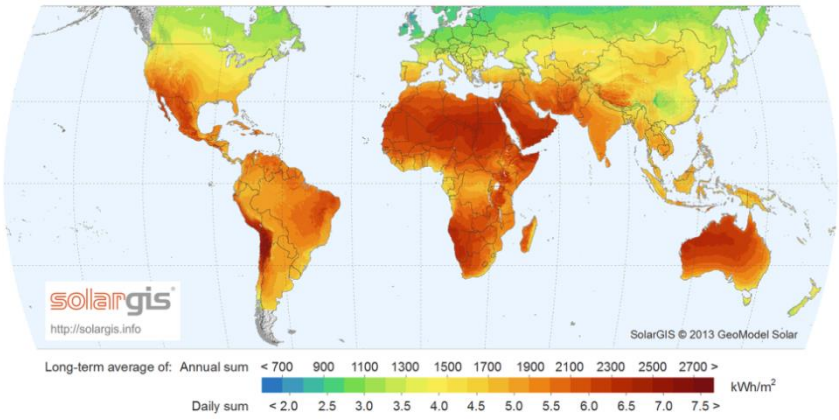


Figure (5.15) Solar Radiation around the World in KWh\m2

Heat transfer has been studied and analysed by scholars, where formulated the following equation (Lienhard, 2007):-

$$Q_{radiation} = A.e.\delta(Ts^4 - T^4sk)$$

Where

Anarea of the building exposed surface(walls and roofs). (m2)

e= emissivity of the external exposed surface of building

δ =Stefan-Boltzmann constant ($5.67x10^{-8}$ W/m^2-K4)

Ts = temperature of the external exposed surface

Tsky = temperature of the sky

The amount of gained heat my external exposed part of houses could be calculated according to the previous equation. Results of calculations could be summarized in the following table:- (Table 5.2)

Table (5.2). Amounts of gained heat by exposed envelope of samples (W\h).

Samples	**H1**	**H2**	**H3**	**H4**	**H5**	**H6**
						
Roof area m2	**57.225**	**44.6**	**51.5**	**180**	**190**	**115**
Exposed walls area m2	**72**	**94**	**88**	**153**	**170**	**336**
emissivity	**clay 0.69**	**wood 0.885**	**steel 0.95**		**concrete 0.94**	
Peak temperature	**49c**					
Gained heat by radiation through roofs W\m2	**855.78**	**885.46**	**497.26**	**1990**	**2192.825**	**4049**

For further and\or easier understanding, results of gained heat in samples could summarized in the following figure. From the following figure (5.16), the highest amount of gained heat is by modern sample (H6) while, lowest amount is by traditional sample (H3). It is referred to that the exposure area which faces direct sun radiation in old houses is bigger than exposure area in modern units. Moreover, from the equation, the exposure area directly proportional to the value of gained heat. (Figure 5.16) (Figure 5.17)

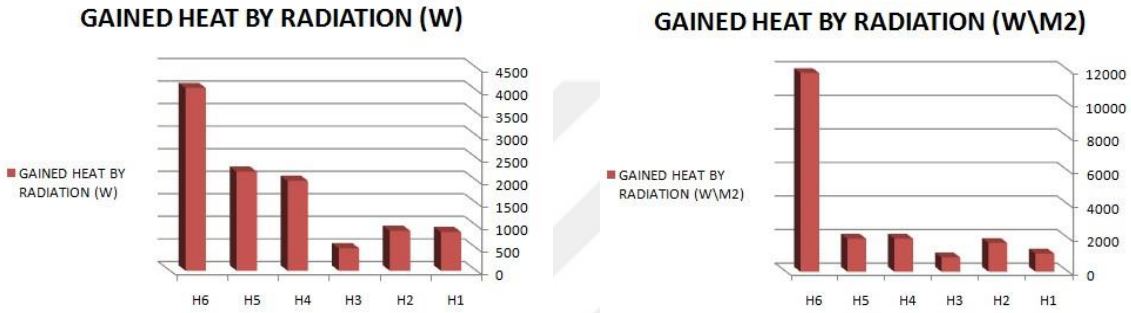


Figure (5.16) The Amounts of Gained Heat by Radiation through Roofs (left) and walls (right) (by author).

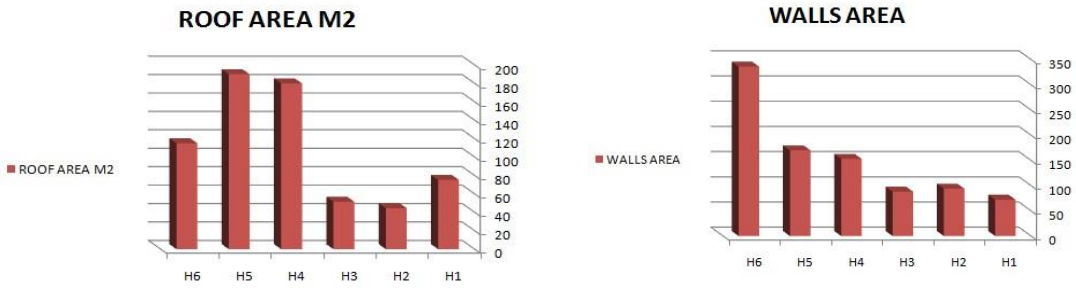


Figure (5.17) Exposure Area of Roofs (left) and Walls (right) (by author).

Exposure area in traditional houses is basically referred to roofs area, where external walls are protected from direct sun radiation by covered streets and detached text. This causes decreasing in gaining heat loads. The main construction material that is used in roofs are clay which is carried by wooden beams made of palm trees.

In contemporary houses, most of them are separated from each other (single unites) which increases the exposure area. This leads to gaining more amounts of heat which influences indoor thermal comfort negatively.

According to daily sun movement curve (Azimuth), the northeast, eastern, southeast, and south are the most exposed elevations to direct sun radiation. Therefore, roofs and walls should be well protected from direct sun radiation.

5.4.2. Conduction

Process of thermal conduction takes a place when heat transfers from one part of body with higher temperature to another with less temperature. In this case heat transfers from molecules to another in slow motion within the body by contacting molecules with each other.

Conducting mechanism could be done in solid, gases and liquids, where transferring process could be in materials faster than others. Heat transfer by conduction in buildings begins from the higher temperature surface into lower temperature, (in hot-dry climates summer the external surfaces is the higher temperature surface, then heat transfers into internal surface within walls and roofs, heat transfer by conduction could calculated according to the following question (Lienhard, 2007):-

$$Q_{conduction} = A.U.\Delta T$$

Where

A= area of surface (m^2)

U= thermal conductivity of the material (W/m^2-K)

ΔT= difference between temperatures of outside and inside air (K)

Field survey of traditional samples indicated that walls are built by under sun dried clay which has low thermal conductivity, roofs are built by clay concrete as well, this clay concrete forms the upper section with thickness of 30cm. The second layer of section is wood beams and palm trees leaves with thickness of 25cm.

In modern houses traditional building materials have replaced with new materials, these materials are seen as a reflection of modernity, and become more desirable than traditional materials because of cost, bigger spans, shorter in construction period, and more organized. These features have led to use concrete materials instead of clay and

palm woods. Walls are built by concrete blocks and covered by cement mortar, roofs are built by concrete and net of constructional steel.

5.4.3. Convection

Transferring heat from one part to another in a fluid (gases or liquids) is known as convection heat transfer, where heat energy transfers from higher to lower temperature by mixing fluid particles and then takes a place at the surface of walls, roofs, and floors. In buildings, heat load that is gained by convection could be calculated by the following equation (Lienhard.2017).:-

$$Q_{convection} = h.A.(T_s - T_f).$$

Where

h= coefficient of heat transfer (w\m^2-k).
A= area of the surface.
Ts= temperature of surface (k).
Tf= temperature of fluid (air) (k).

The value of heat transfer depends on:-

a. Velocity of the fluid (wind speed).

b. Physical properties of the fluid.

c. Area of Surface and its orientation.

Then, generally, thermal performance of buildings is affected by gaining heat in three main mechanisms (radiation, conduction and convection). In particular, in desert climate the amount of gained heat depends on several factors such as house design, ambient temperature, ventilation, orientation and protection as well as thermal feature of construction materials. Therefore, thermal properties of samples should be analyzed to find out the relationship between buildings and their thermal performance.

5.5. Heat Transfer and Thermal Properties of Houses Envelope

The envelope of houses (external parts of building) represents the shield which protects from harsh climate conditions of desert. In the previous section results show that contemporary houses are gaining heat more than traditional dwellings, according to heat transfer calculation this case is referred to the thermal properties of house envelope materials which is considered as the main defensive part against hot-dry climate conditions. The main thermal properties that influence heat transfer could be classified into thermal emissivity, conduction, and convection.

5.5.1. Thermal Emissivity

Emissivity is defined as the ratio of the heat radiation from a surface to a typical black surface at the same temperature as given by the Stefan–Boltzmann law. The ratio ranges between 0 to 1while the emissivity ratio of black surfaces is close to 1 and light surfaces ratio is close to aero. The object of a black surface emits thermal radiation at the rate of about 448 watts per square meter at room temperature (25 °C, 298.15 K); real objects with emissivities less than 1.0 emit radiation at correspondingly lower rates (Trefil, James S, 2003). In Ghadames houses the variation of building materials from mud, wood and gypsum to concrete and constructional steel has affected the thermal performance of houses envelope. The following table shows the emissivity of main building materials in both of modern and old buildings:- (Table 5.3)

Table (5.3) thermal Emissivity of the Used Building Materials (source ASHREA55).

Building material	**Mud** 	**Wood** 	**Gypsum** 	**Concrete** 	**Constructional steel** 
Emissivit (0-1)	**0.69**	**0.385**	**0.35**	**0.95**	**0.94**

The comparison between emissivity values of both of modern and traditional envelopes materials, leads to that old-muddy houses emit amounts of heat less than concrete and constructional steel which are used in contemporary buildings.

Lacking of the awareness of households and replacing low emissivity materials with high emissivity concrete materials caused gaining more amounts of heat in concrete envelope more than mud-wood constructions while the emitted heat works on increasing of ambient temperature which is not undesirable state especially during summer days. The more emitted heat, the less thermal comfort is.

5.5.2. Thermal Mass

Thermal mass is defined as the ability of construction materials to absorb, store, and later release heat loads that are gained by radiation, conduction and convection in (kJ/kg.K). The amount of heat needed to rise temperature of material by 1K and its density. In another meaning the thermal mass can be estimated by its volumetric heat capacity (Kj\m^3.K) which is the value of energy stored in a unit volume of material (m^3) for 1K rise in temperature.

Yannas, (2003) as the ability of a building to store and release heat at different periods of the day. Thermal capacity is defined as “the energy required to raise the temperature of a layer of material”. Usually, “higher density substances are having higher thermal capacity.

External envelope materials density and thickness of dwelling are important factors affect on thermal mass of building. Materials with high thermal mass absorb, store heat and hold it for much longer time than lower thermal mass materials do.(EBN volume 1998).

As soon as, sun radiation touches the external parts of a building, heat energy begins transferring from outside into inside environment. In this case, the external surfaces (walls and roofs) become the main heat conductor.

In summer days in Ghadames city climate, according to noticed temperatures that are registered by field survey, temperature starts rising from 7 am (morning) then it reaches the peak at 4 pm (afternoon) which ranges between 45^0 C and 50^0 C.

It is well known that temperature with 45^0C-50^0C is much more than human body thermal comfort temperature which is between 27^0C-32^0C. Therefore, to avoid sneaking over heat temperature from outside into inside, or losing heating loads in cold weather, the external envelope of dwellings should be built by materials with high thermal mass to expand lag time or delay time.

Vernacular houses in Ghadames were built basically by local building materials which are extracted from the surrounding environment such are clay and palm trees wood. This had led to create an envelope of thick clay walls and roofs.Thermal mass of clay or earth walls is:- (Table 5.4)

Table (5.4) Thermal Mass of Clay and Concrete (David Baggs & Neal Mortensen 1995).

Material	Density (Kg/m^3)	Specific heat (KJ/kg.K)	**Volumetric heat capacity thermal mass** ($kJ/m^3.K$)
Concrete	**2240**	**0.920**	**2060**
Earth Wall	**1550**	**0.837**	**1300**

In contemporary houses building materials have changed where, walls are built by concrete blocks and roofs are constructed by heavy reinforced concrete which is entirely different from clay envelope.By comparison, contemporary house envelope materials have thermal mass is much more than the envelope of traditional house.

This is referred to the difference of density of clay and concrete. In another meaning, concrete has ability to store gained heat more than clay. Greater thermal mass (heavier, denser materials) can store more heat (K. Gregory, B. Moghtaderi, H. Sugo and A, 2008).Materials with higher value of thermal mass have more ability to store heat and take longer time to release it this phenomenon is called "time lag".

5.5.3. Time Lag

In hot-dry regions, heat transfers through building within elements such as, walls, roofs and openings. Heat passing heat through a specific body takes a period of time. When external heat achieves peak, indoor temperature remains lower, then later indoor temperature achieves peak. Lag time is time span between external peak temperature and indoor peak temperature. (S. A. Al-Sanea, M. F. Zedan and S. N. Al-Hussain 2012).Time lag is being identified in other studies as delay time or decrement time.

Sanders and Shepherd (2009), have highlighted that time lag is time span between achieving peak temperatures at external and internal surfaces of a wall. Building substances allow the heat to transfer at various rates. The period of time it takes the peak temperature on the external surface of building (such as a wall or a roof) to make its way to a peak temperature on the internal skin, is called the time lag or decrement delay (B.D.A. 2014). (Figure 5.18)

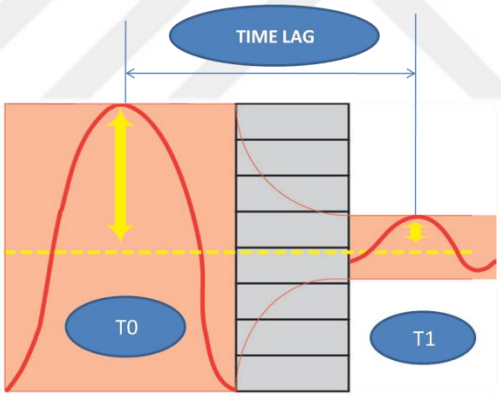


Figure (5.18) Time Lag (Delay Time), (B.D.A. 2014).

Decrement delay or lag time value reflex the thermal conductivity of each envelope materials, where, the higher thermal conductivity, the shorter lag time. (Table 5.5)

Table (5.5) Time Lag (Decrement Delay) of Various Building Materials (David Baggs & Neal Mortensen 1995).

Material (thickness in mm)	**Time lag** (hours)
Concrete (250)	**6.9**
Double Brick (220)	**6.2**
Adobe (250)	**9.2**
Rammed Earth (clay walls) (250)	**10.3**
Compressed Earth Blocks (250)	**10.5**
Sandy Loam (1000) 30 days	**30 days**

Decrement factor is the capacity of temperature fluctuation on indoor surface of wall divided by external surface (David Baggs & Neal Mortensen 1995).In another meaning decrement delay is the difference between maximum external temperature and maximum internal temperature. In well insulated buildings, the reduction rate of decrement factor is higher than non-insulated envelope. Building materials that have lower decrement factor are having higher thermal conductivity, and the opposite, building materials with higher decrement factor are having lower thermal conductivity, then more thermal resistance.

5.5.4. Thermal Conductivity

In thermodynamic theory, Thermal Conductivity is defined as the ability of materials to conduct heat, where heat transfers from high temperature part to low temperature. In buildings, thermal conductivity is the ability of building parts to transfer heat from outside surface to inside surface of wall and roof.

According to Fourrers law thermal conductivity can be measured according to the following equation

q=-k.dt\dx

where

q the amount of transferred heat

k thermal conductivity coefficient.

dt= the difference between high and low temperature.

dx=thickness of medium (wall or roof).

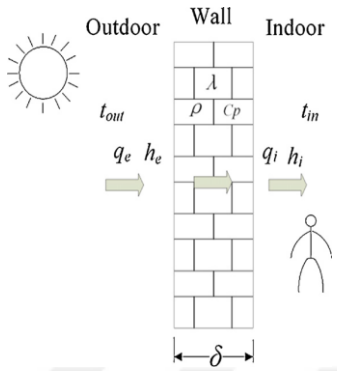


Figure (5.19) Heat Transferring Through Wall

Thermal conductivity of building envelope depends on type of construction materials and thickness of the envelope (Figure 5.19).

i. Type of construction materials

According to previous physical studies had been done on materials, thermal conductivity of traditional house materials are:-

Table (5.6) Thermal Conductivity of the Used Materials (Pete walker, 2009).

Material	**Thermal conductivity (w\m^2.k)**
Clay	**0.4-1.6**
Wood	**0.12**
Hollow concrete blocks (20 cm)	**2.9-5**
Concrete	**2.3-2.5**
Steel	**45.3**

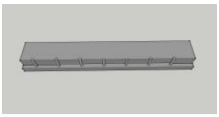
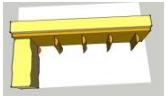
In contemporary houses, clay and wood had been replaced with concert, constructional steel and hollow concrete blocks. By comparison it is obvious that contemporary houses are built by materials with higher thermal conductivity than traditional houses materials. This explains the reason behind gaining concrete building heat more than vernacular houses.

ii. Thickness of The Envelope

According to thermal conductivity equation q=-k.dt\dx, thickness of conductor (walls and roof) inversely proportional with heat amount that transferred within envelope elements. In Ghadames vernacular houses, walls are built with thickness of about 70cm

With lower thermal conductivity materials (mud and wood). On the other hand, in contemporary units and according to observation to construction stages of similar buildings, external and internal walls are built with hollow concrete blocks with thickness of about 25cm. This type of blocks became the common material of walls in the whole city. This type has higher thermal conductivity than mud walls and lower thermal resistance as well. This explains the reason of gaining higher amounts of heat in contemporary buildings than traditional houses. (Table 5.7).

Table (5.7)Thickness of External Envelope Parts (source, author).

ENVELOPE PART	Modern concrete wall	Traditional muddy wall	Modern concrete roof	Traditional muddy roof
THICKNESS cm	 **25**	 **60**	 **15**	 **30-40**

5.6. Passive Cooling Strategies in Ghadames

In the harsh conditions of arid zones, it is highly recommended that hose design should utilize the elements of ambient environment to increase thermal performance of buildings. Passive cooling control is one of the most important strategies that has been used to enhance the thermal performance of buildings.

5.6.1. Definition of Passive Cooling Design

Generally, Passive Design has been defined as a "*utilizing the advantages of nature as maximum as possible to create a more suitable environment without using mechanical means for heating or cooling*" (Almansuri, 2002).

Dowdle (2003), has defined the passive design as "*a process to develop ideas and strategies for the design of whole buildings that have minimal dependence on mechanical means*". Thus, passive cooling design basically depends on utilizing natural advantages of local environment.

5.6.2. Strategies of Passive Cooling Design in Old Houses

Primitive builders of Ghadames city had discovered that they have to apply several techniques to protect occupants from tough desert climate conditions, where they used several techniques such as:-

a. Utilizing natural ventilation and air circulation, and
b. Using the compact urban fabric.

a.Utilizing natural ventilation and air circulation

Clancy (2013), has summarized the importance of natural ventilation in hoses as (fresh air provider, reduce contaminated gases, increase thermal comfort).

In Ghadames city, it is well known that external temperature exceed 45c which makes the ambient air currents very hot. This type of currents is not allowed to inter inside the house. Therefore, traditional houses were built to circulate air currents by using windows in top roofs to replace hot and contaminated air with fresh cold air that comes down at night which rises the thermal comfort inside the house. (Figure 5.20, and Figure 5.21)

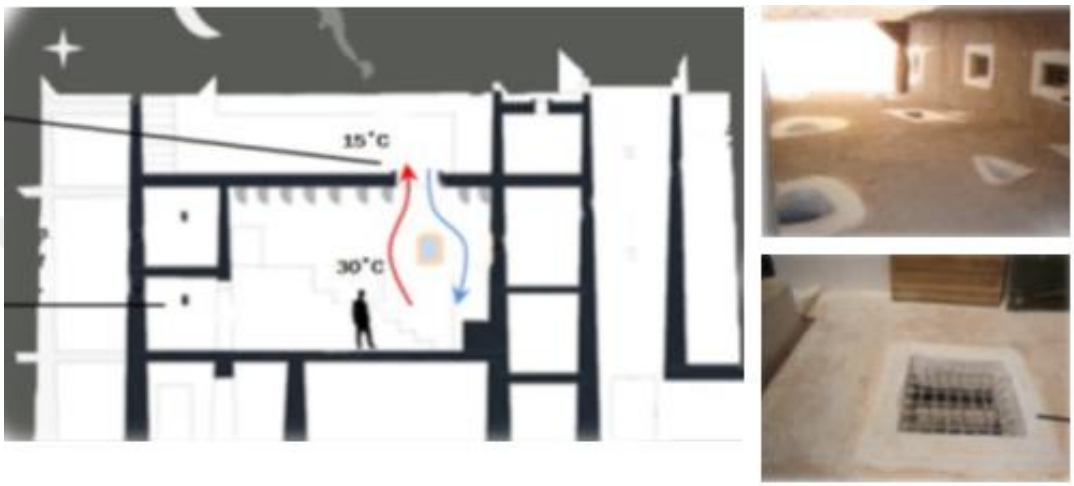


Figure (5.20) Air Circulation during Night (Source, Alabid, 2002).

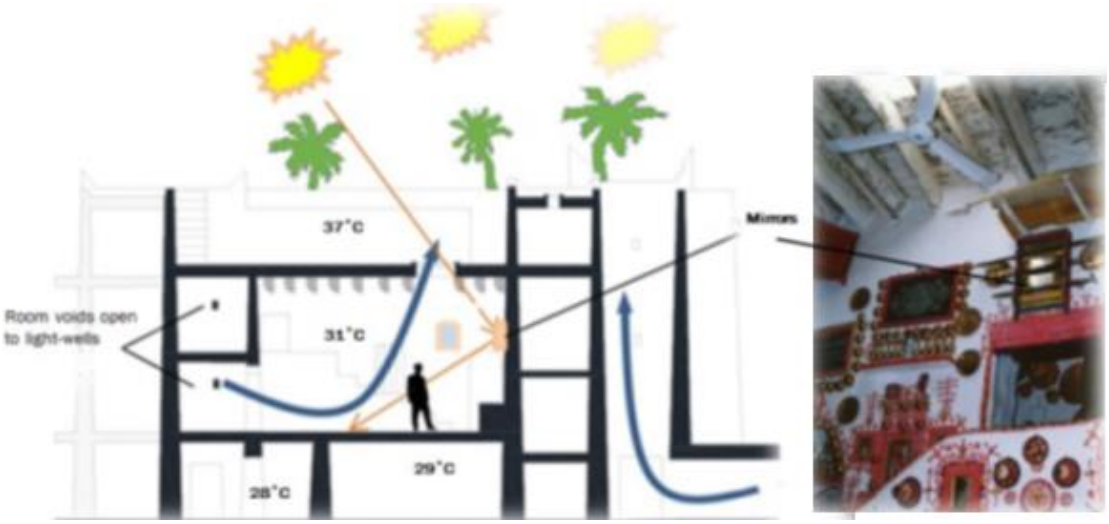


Figure (5.21) Air Circulation during Day (Source, Alabid, 2002).

This air circulation process explains why traditional houses keep coolness during day time.

In modern houses design, the air ventilations depends on horizontal distribution of air flow, this type of ventilation is referred to the size and distribution of windows were

they built in big sizes and directly facing the external air currents. This type of air movement makes indoor temperature rapidly increases and reduces the thermal comfort inside the house.(Figure 5.22).

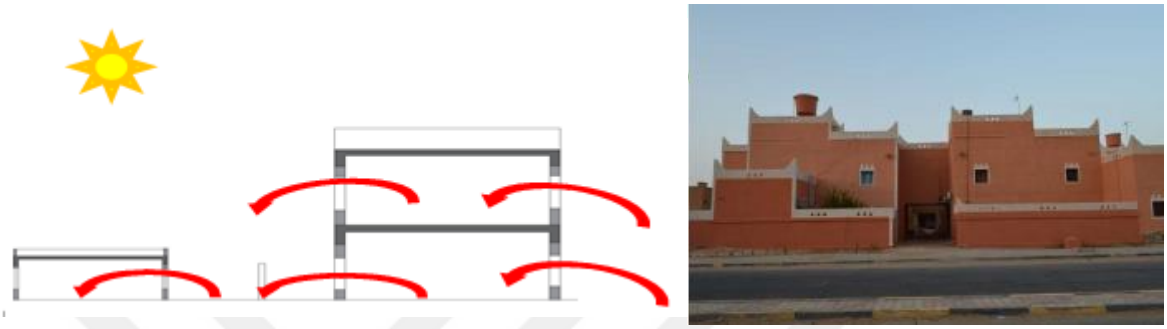
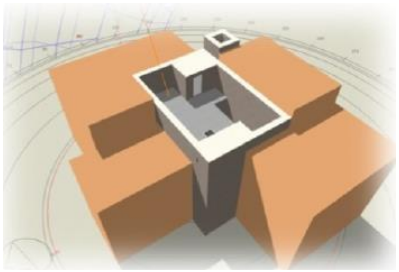


Figure (5.22) Explanatory Sketch for air Ventilation in Modern Houses (Source:author, 2018).

b. Using the Compact Urban Fabric

As previously mentioned, Most of the traditional settlements in hot-dry regions are characterized by the compact urban texture, this type of fabric used to resist both of hot-sandy storms that occur in summer and cold air currents in winter and not allowing them to cross into theheart of the settlement.

Minimizing the exposure area for the direct sun rise is very important target which was achieved by attaching the building to each other. This strategy caused notable decreasing in gained heat by radiation (Figure 5.23).



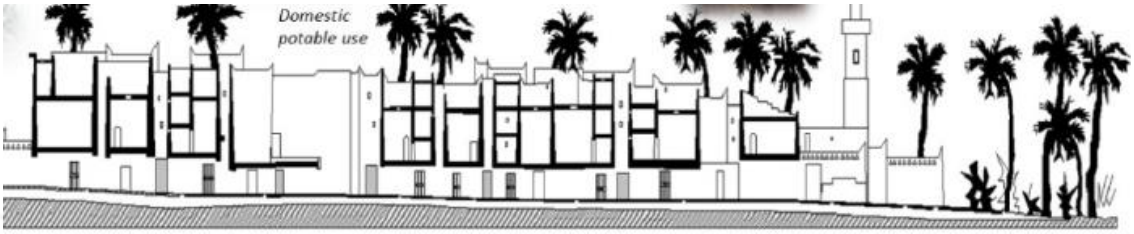


Figure (5.23) Using the Compact Urban Fabric Minimizes Gained Heat
(Source, author, 2018).

Occupants of the old city used to move from early morning to the sunset outside of their houses for agriculture and other daily life style requirements, during summer days, it is impossible to move under direct sun. Therefore, they created a magnificent system of non-straight covered (shaded) passageways to allow them to move within the city without harm. The more go deeper inside the settlement the lower temperature is (Figure 5.24).

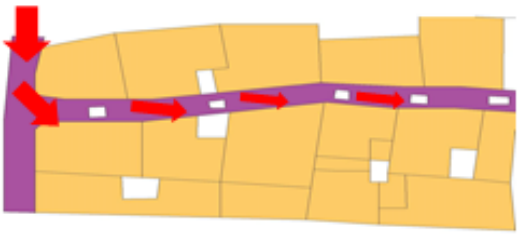


Figure (5.24) Sample Network of the Non-Straight Covered Passageways
(Source, author, 2018).

In modem city, the urban fabric has been changed to the modern open texture, this is referred to the influence of modernism on life style requirements (Figure 5.25).

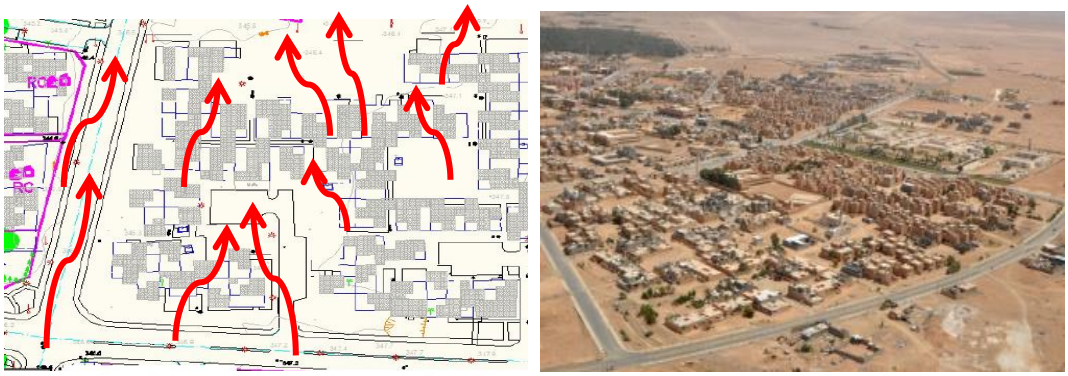


Figure (5.25) Sample of Modern-Open Urban Texture (Source, author, 2018).

The open urban texture of the new part is basically consisted of private-single houses built in one or two floors. Un-desired air currents move through buildings almost with the same velocity within this type of texture. These currents impacts the external envelope of houses (see figure, 5.22) and rapidly increase or decrease indoor temperature of houses which affect negatively on thermal satisfaction and force users to use alternative mechanical heaters or air conditioners. This causes increasing in the consumed amounts of energy.

5.7. Interim Conclusion

The extracted data, whether from field measurements or calculated by the previous equations shows that transformation from traditionalism to modernism has caused replacing natural materials with concrete, aggregate, cement and steel has led to create differentiation in thermal performance and gained heat by the external envelope of samples.

The concrete buildings transfer and gain heat faster and more than old mud houses which is not suitable for desert climate. This phenomenon has forced users to use air conditioners in summer and electrical heaters in winter which causes increasing in the consumed energy.

6. SUMMARY AND CONCLUSIONS

The traditional houses of Ghadames city were built by natural materials (organic architecture) to meet the needs of physical protection and privacy which have become the most important features of these houses.

1. According to literature and questionnaire results there are few important considerations that affected directly on forming of the traditional houses layouts. These determinants are:-

a. Socio-cultural and privacy considerations, especially controlling social interaction and visual privacy which had been the major determinant of spatial organization of houses and old settlement.

b. Builders of traditional houses had been aware of the major role of climate in desert zones in terms of house design, building materials, forming the external envelope and city planning.

c. The architectural style of traditional houses is generally characterized by the harmony in form and colors.

2. New modern houses have been built by the government to move the inhabitants of traditional city to these modern houses which were designed and built by foreign designers and companies. Occupants of the old city had been fascinated by the new modern houses which provide electricity, water and sewage networks. New type of houses is totally different from the traditional houses.

Modernity has affected the architectural features of Ghadames houses architecture in three aspects:-

i. Changing of building materials

Where natural materials such as mud or clay, palm trunks and gypsum were replaced with modern concrete materials, this change had led to the creation of modern houses with low thermal resistance envelop which has caused reducing of thermal comfort and depending on mechanical and electrical means to provide thermal comfort.

iii. **Changing of House Design**

Nowadays houses designs are being seen as a sort of modernity and people of Ghadames amazed by these new designs which has caused building new neighborhoods are quite different from traditional designs. Modern designs have produced houses with less visual privacy which had been considered as a major determinant in the social relationships within Ghadames society.

iv. **Changing in Urban Fabric**

Because of occurring of cars and modern transformation machines and the requirements of new life style such as hospitals, schools and entertainment , the urban fabric transformed from the compact fabric with multi-level shaded streets to one level uncovered streets which is not suitable for hot-dry desert climate where the extreme temperature and hot sandy storms in summer. As well as increasing of the exposure surface area of buildings which causes negatively on the thermal performance of dwellings. The ineffective thermal performance of contemporary buildings envelope causes increasing of consumed energy which affects negatively on the ambient environment.

Then, modernity as a process transformation from vernacularism into modernism has affected negatively on the architectural features of traditional houses, this phenomenon has took a place because of using building materials without assessment of their ability to deal with harsh desert climate.

Designer, engineers, and builders are responsible for the new designs that are not as successful as traditional houses.

3.Spatial organization and privacy measurements indicate that Ghadamesians are a conservative society and they built their dwellings to provide them as much as possible of visual privacy which is found less in modern houses.

Therefore, designing modern houses in Ghadames should take into consideration these requirements and designers should prepare their designs according to socio-cultural and climate considerations.

The empirical study had been conducted in site by the author by using several methodologies to investigate the impact of modernity on the architectural features of desert house of Ghadames city. These methods varied from measuring instruments to softwares and questionnaire. The methodologies used are shown the results that validate the research hypothesis. New research should be conducted to improve further approach to prepare design criteria chechklists or handbook to use traditional advantages in newly designed desert houses.

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URL1 https://sunnah.com/riyadussaliheen

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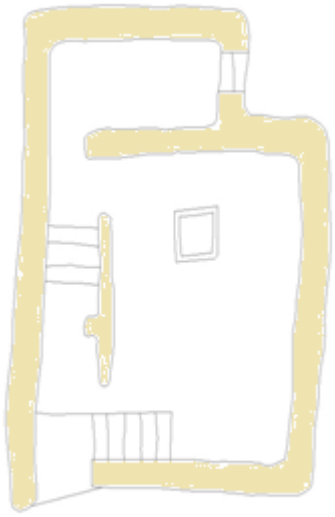
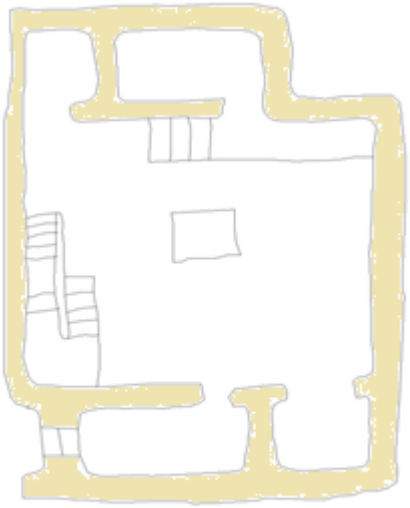
APPENDIX A:PLANS OF SAMPLE HOUSES

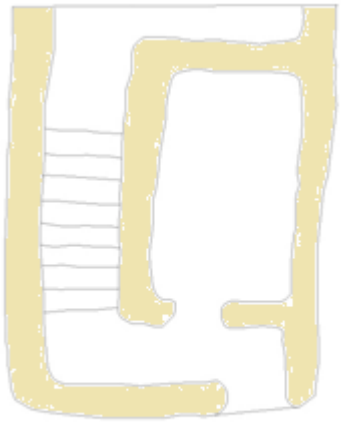
SAMPLE1 (H1)



GROUND PLAN



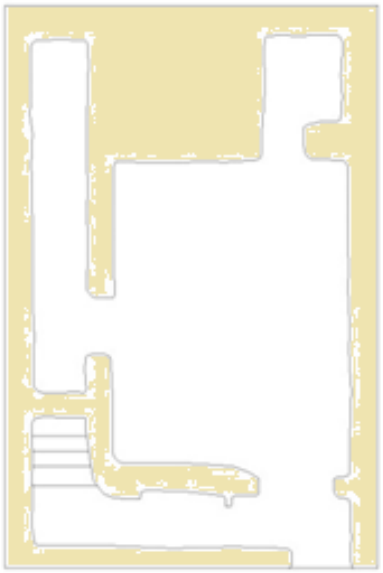
FIRST FLOOR PLAN



SECOND FLOOR PLAN (TOP)

SECTION

SAMPLE2 (H2)



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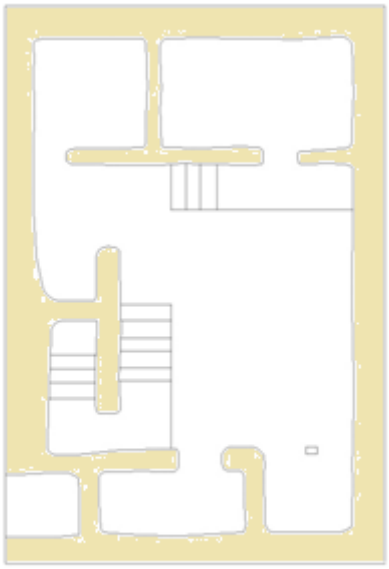

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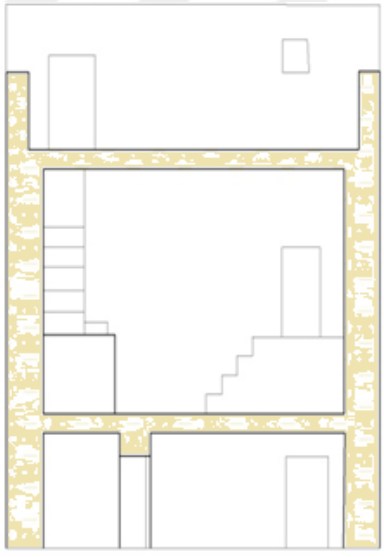
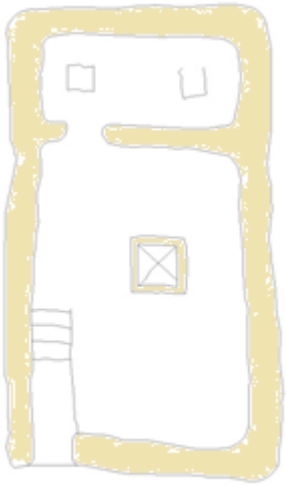


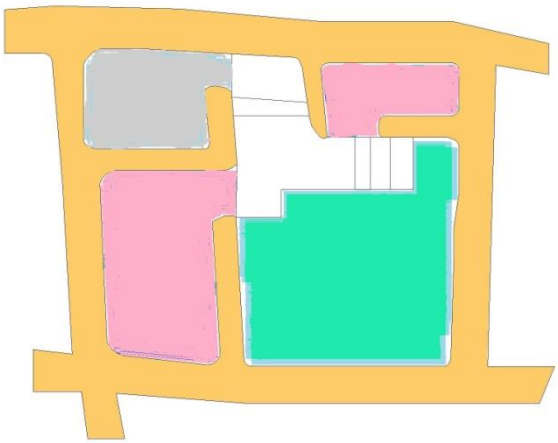
SECTION



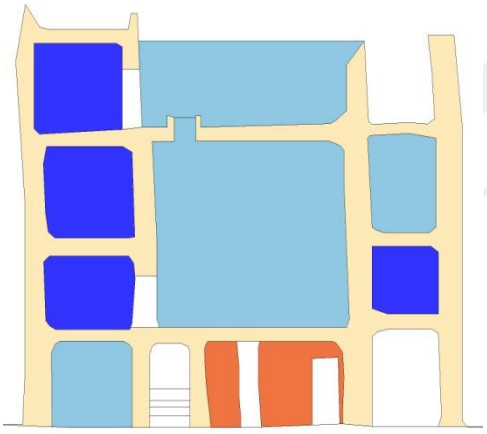
TOP FLOOR PLAN

SAMPLE2 (H3)

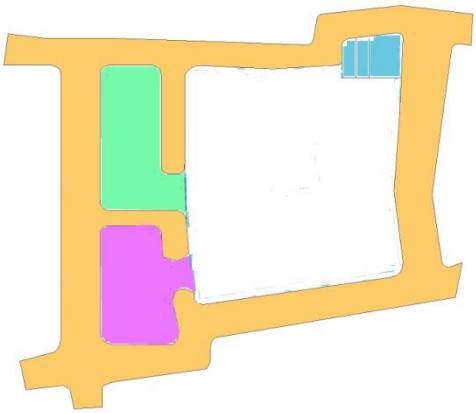
Ground Floor



First Floor



Section



Top Floor

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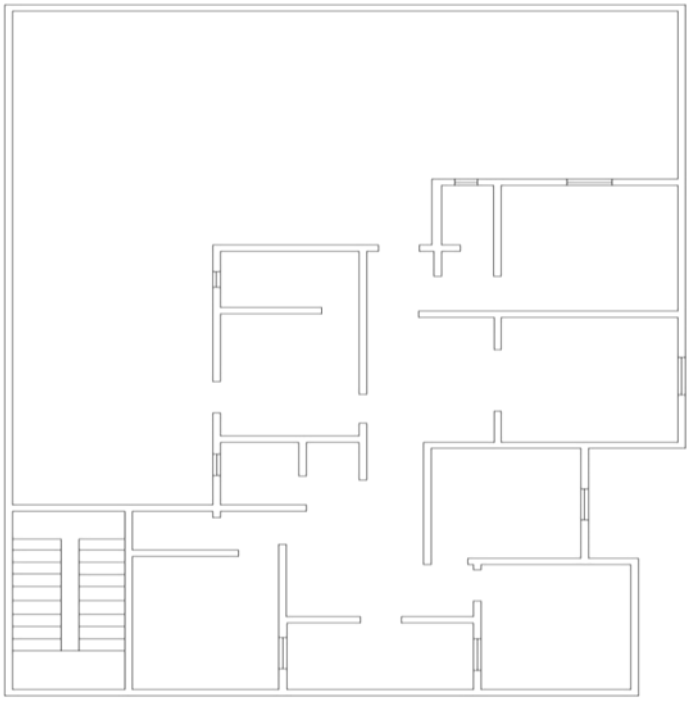
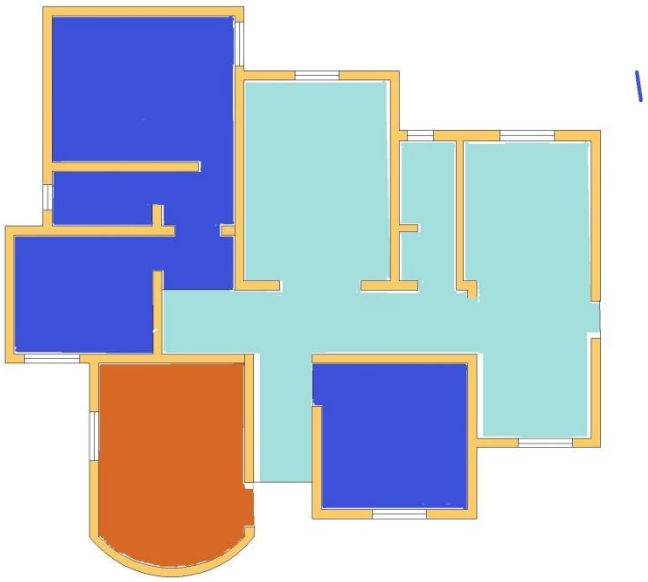


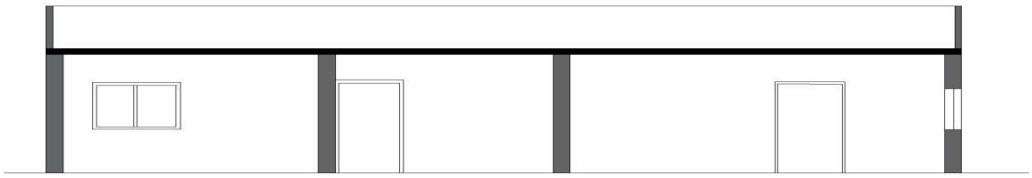
Ground floor

Section

SAMPLE3 (H5)

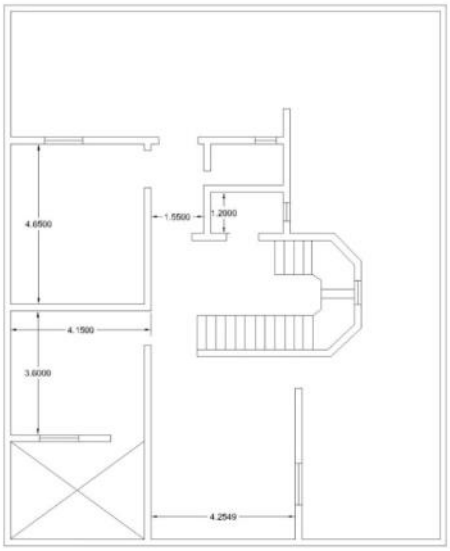


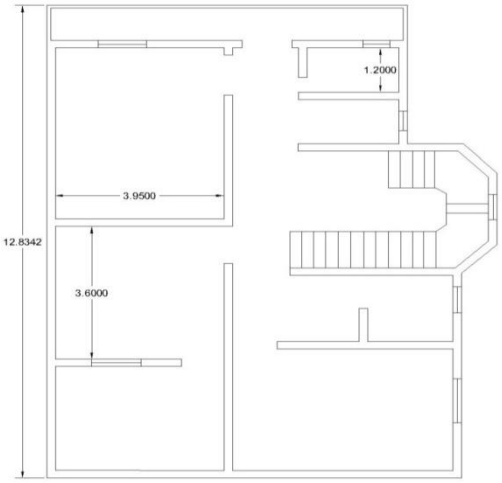
Plan



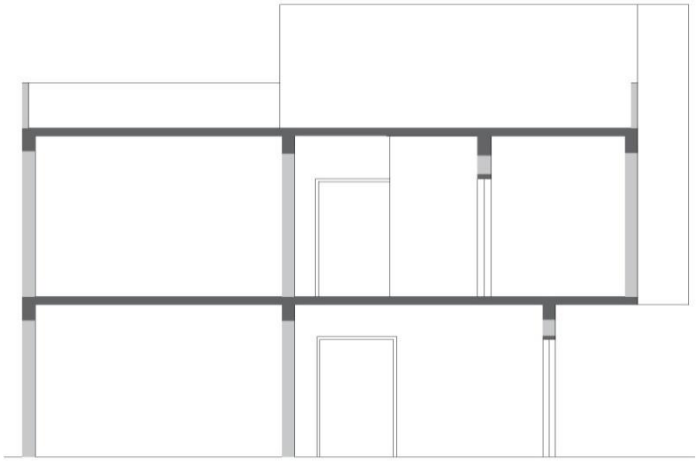
Section

SAMPLE4 (H6)





Ground floorFirst floor



Section

DESCRIPTIVE STATISTICS OF JUSTIFY GRAPH ANALYSIS

		TDn	MDn	RA	i	CV
0	street	51	4.25	0.59	1.69	0.33
1	entrance	41	3.41	0.43	2.27	2.50
2	storage	51	4.25	0.59	1.69	0.33
3	stairs	35	2.91	0.34	2.86	0.50
4	stairs	40	3.33	0.42	2.35	0.66
5	living hall	31	2.58	0.28	3.47	3.83
6	kids b.r	41	3.41	0.43	2.27	0.16
7	master b.r	37	3.08	0.37	2.64	1.16
8	8	156	13.00	2.18	0.45	0.00
9	parents space	41	3.41	0.43	2.27	0.16
10	bath room	40	3.33	0.42	2.35	0.66
11	kitchen	46	3.83	0.51	1.94	0.83
12	roof	46	3.83	0.51	1.94	0.83
	Min	31.00	2.58	0.28	0.45	0.00
	Mean	**50.46**	**4.20**	**0.58**	**2.17**	**0.92**
	Max	156.00	13.00	2.18	3.47	3.83

		TDn	MDn	RA	i	CV
0	street	43	3.30	0.38	2.60	0.33
1	entrance	31	2.38	0.23	4.33	1.66
2	storage	39	3.00	0.33	3.00	2.33
3	storage a	51	3.92	0.48	2.05	0.33
4	storage b	51	3.92	0.48	2.05	0.33
5	stairs	27	2.07	0.17	5.57	1.00
6	bathroom	32	2.46	0.24	4.10	0.50
7	living hall	26	2.00	0.16	6.00	4.16
8	kids b.r	38	2.92	0.32	3.12	0.16
9	master b.r	38	2.92	0.32	3.12	0.16
10	stairs	34	2.61	0.26	3.71	1.16
11	kitchen	45	3.46	0.41	2.43	0.83
12	roof	45	3.46	0.41	2.43	0.83
13	parents place	38	2.92	0.32	3.12	0.16
	Min	26.00	2.00	0.16	2.05	0.16
	Mean	**38.42**	**2.95**	**0.32**	**3.40**	**1.00**
	Max	51.00	3.92	0.48	6.00	4.16

Sample1 (H1)Sample2 (H2)

		TDn	MDn	RA	i	CV
0	**0**	27	2.70	0.37	2.64	2.50
1	**1**	36	3.60	0.57	1.73	0.33
2	**2**	36	3.60	0.57	1.73	0.33
3	**3**	22	2.20	0.26	3.75	0.58
4	**4**	19	1.90	0.20	5.00	2.83
5	**5**	28	2.80	0.40	2.50	0.25
6	**6**	28	2.80	0.40	2.50	0.25
7	7	28	2.80	0.40	2.50	1.83
8	**8**	37	3.70	0.60	1.66	0.33
9	**9**	22	2.20	0.26	3.75	1.08
10	**10**	29	2.90	0.42	2.36	0.66
	Min	19.00	1.90	0.20	1.66	0.25
	Mean	**28.36**	**2.83**	**0.40**	**2.74**	**1.00**
	Max	37.00	3.70	0.60	5.00	2.83

Sample3 (H3)

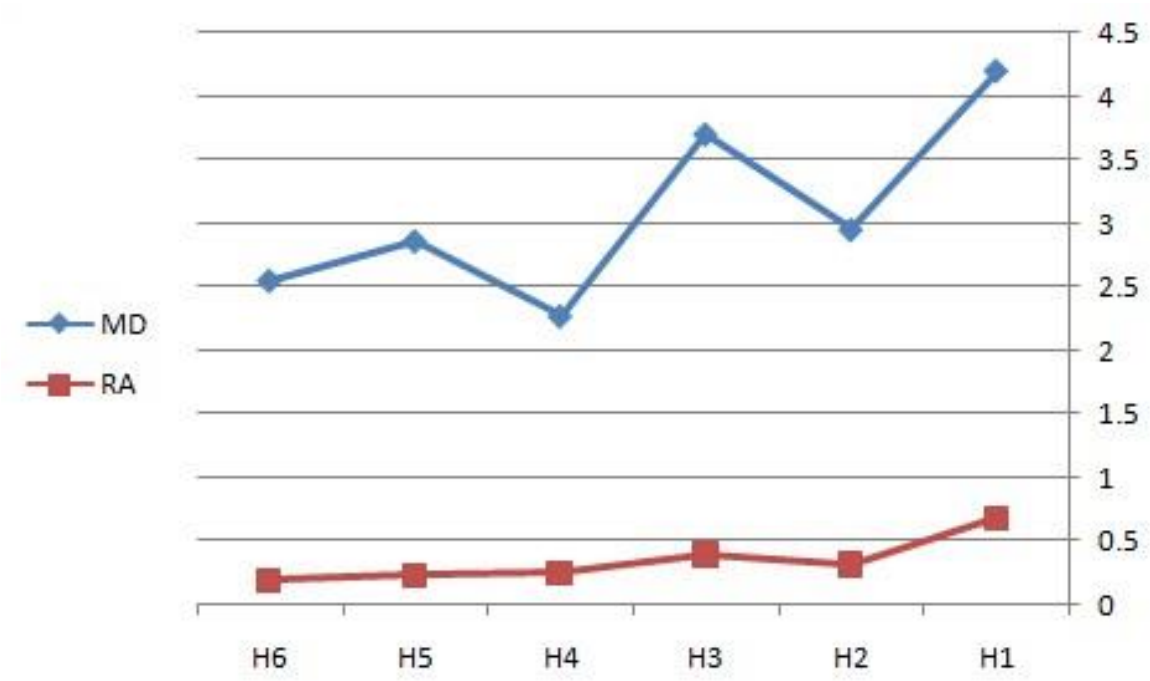
		TDn	MDn	RA	i	CV
0	0	46	2.87	0.25	4.00	0.58
1	1	37	2.31	0.17	5.71	1.75
2	2	51	3.18	0.29	3.42	0.75
3	3	51	3.18	0.29	3.42	0.75
4	4	30	1.87	0.11	8.57	1.75
5	5	45	2.81	0.24	4.13	0.25
6	6	38	2.37	0.18	5.45	1.58
7	7	53	3.31	0.30	3.24	0.33
8	8	46	2.87	0.25	4.00	1.83
9	9	61	3.81	0.37	2.66	0.33
10	10	33	2.06	0.14	7.05	2.91
11	11	46	2.87	0.25	4.00	0.50
12	12	45	2.81	0.24	4.13	1.16
13	13	48	3.00	0.26	3.75	0.16
14	14	45	2.81	0.24	4.13	1.16
15	15	46	2.87	0.25	4.00	0.50
16	16	57	3.56	0.34	2.92	0.66
	Min	30.00	1.87	0.11	2.66	0.16

		TDn	MDn	RA	i	CV
0	courtyard	50	3.12	0.28	3.52	0.75
1	entrace	39	2.43	0.19	5.21	3.00
2	w.c	54	3.37	0.31	3.15	0.25
3	male guests room	54	3.37	0.31	3.15	0.25
4	corridor	32	2.00	0.13	7.50	0.35
5	female and living room	36	2.25	0.16	6.00	0.60
6	kitchen	38	2.37	0.18	5.45	1.10
7	couryard	53	3.31	0.30	3.24	0.50
8	stairs	25	1.56	0.07	13.33	4.50
9	courtyard	43	2.68	0.22	4.44	1.00
10	boys b.r	39	2.43	0.19	5.21	0.60
11	bathroom	39	2.43	0.19	5.21	0.60
12	girls b.r	39	2.43	0.19	5.21	0.43
13	storage	39	2.43	0.19	5.21	0.43
14	master b.r	38	2.37	0.18	5.45	0.93
15	bathroom	38	2.37	0.18	5.45	0.93
16	balcony	38	2.37	0.18	5.45	0.76
	Min	25.00	1.56	0.07	3.15	0.25
	Mean	**40.82**	**2.55**	**0.20**	**5.42**	**1.00**

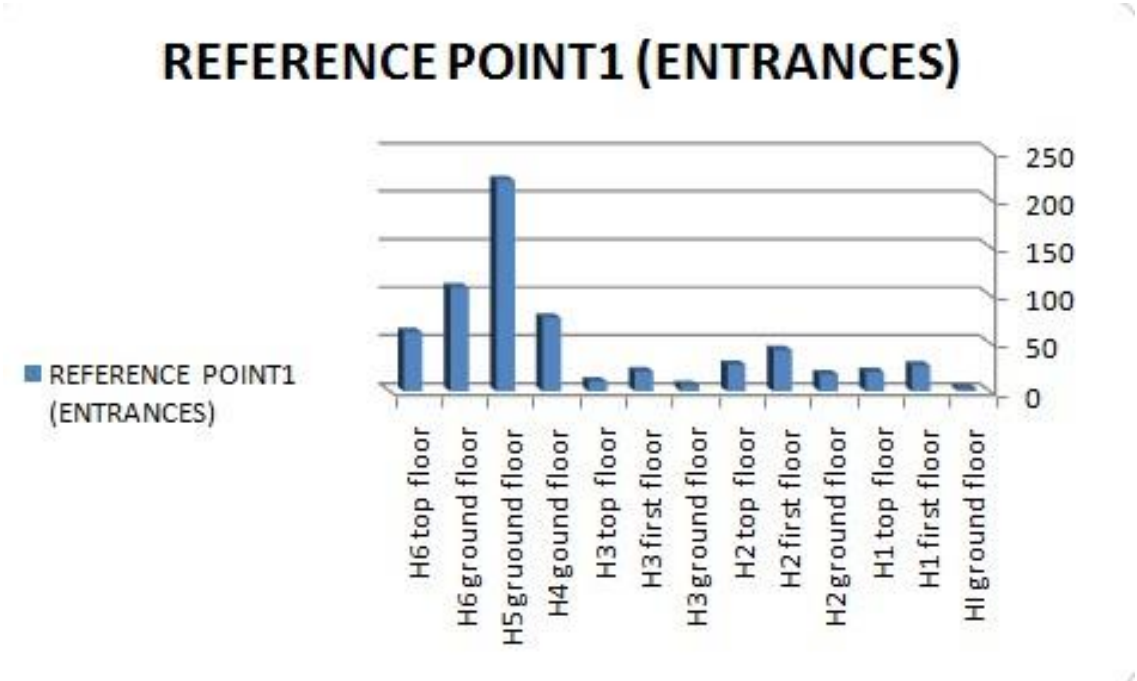
Sample4(H4)Sample 5 (H5)

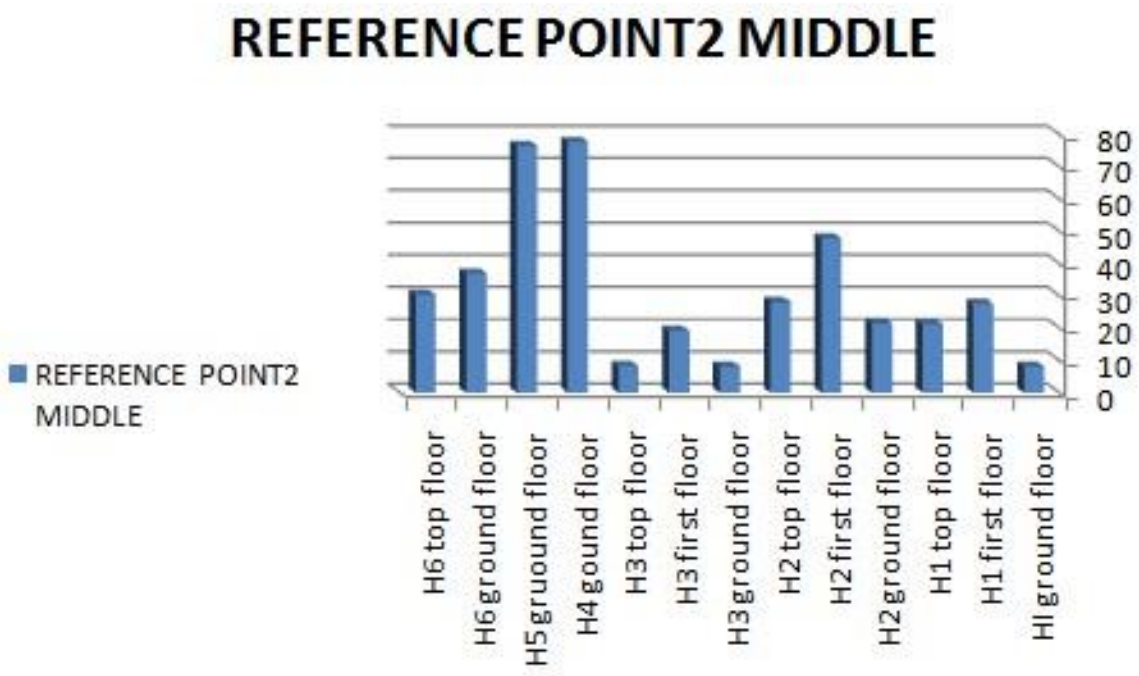
		TDn	MDn	RA	i	CV
0	0	22	2.00	0.20	5.00	1.64
1	1	32	2.90	0.38	2.61	0.33
2	2	23	2.09	0.21	4.58	0.47
3	3	15	1.36	0.07	13.75	4.00
4	4	25	2.27	0.25	3.92	0.14
5	5	25	2.27	0.25	3.92	0.14
6	6	21	1.90	0.18	5.50	1.14
7	7	23	2.09	0.21	4.58	0.47
8	8	22	2.00	0.20	5.00	1.64
9	9	32	2.90	0.38	2.61	0.33
10	10	30	2.72	0.34	2.89	0.83
11	11	30	2.72	0.34	2.89	0.83
	Min	15.00	1.36	0.07	2.61	0.14
	Mean	**25.00**	**2.27**	**0.25**	**4.77**	**1.00**
	Max	32.00	2.90	0.38	13.75	4.00

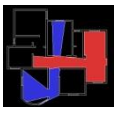
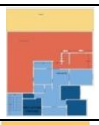
Sample 6 (H6)

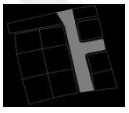


Mean Depth (MD) and relative asymmetry (RA) of samples (source, author, 2017).

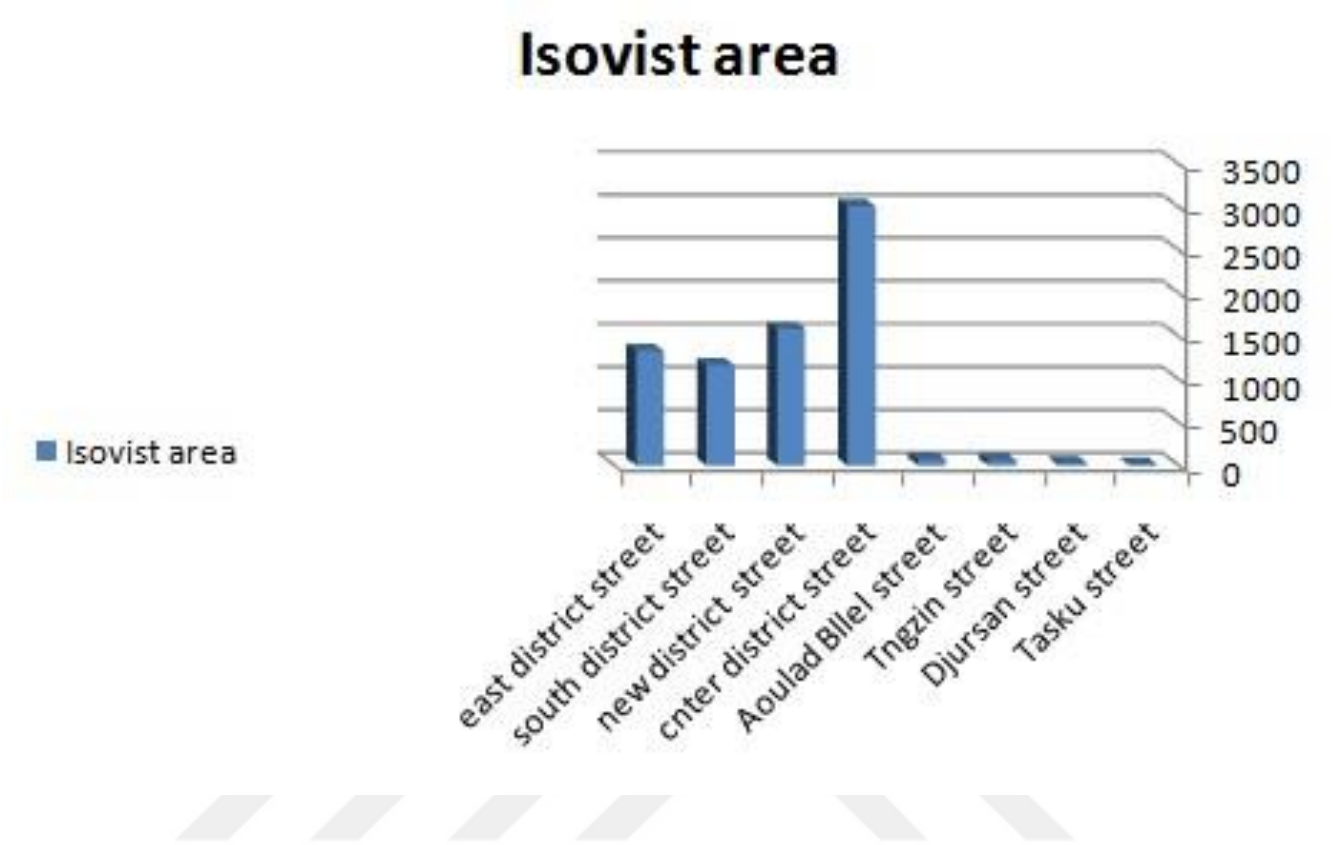



REFERENCE POINT2 MIDDLE
REFERENCE POINT2 MIDDLE
80
70
60
50
40
30
20
10
0
H6 top floor
H6 ground floor
H5 gruound floor
H4 gound floor
H3 top floor
H3 first floor
H3 ground floor
H2 top floor
H2 first floor
H2 ground floor
H1 top floor
H1 first floor
Hl ground floor

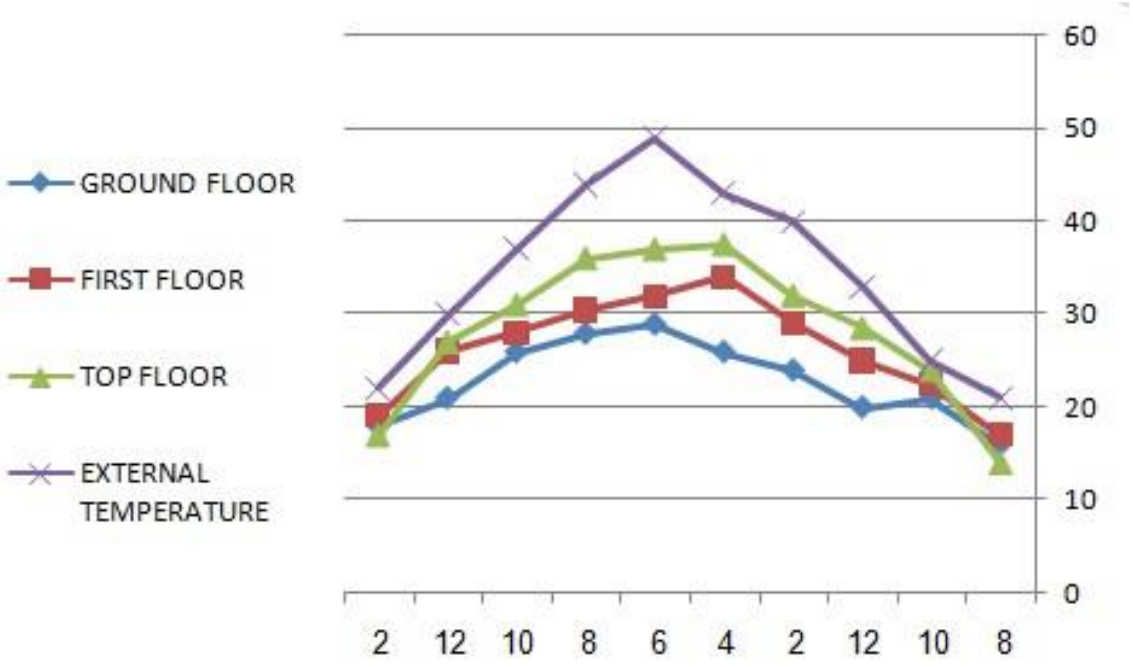
samples	plans		Isovist at Reference pointEntrances m^2		Isovist at Reference point middle m^2	
TRADITIONAL HOUSES	H1			3.01		8.1
				26.7		27.55
				20.2		21.029
	H2			17.65		21.57
				43.17		47.88
				27.57		28.12
	H3			6.2		8.2
				20.6		19.2
				10.3		8.3
CONTEMPORARY HOUSES , AND	H4			76.39		77.72
	H5			219.56		76.53
	H6			107.9		37
				61.25		30.35

Sample (street)	Reference point (middle)	Isovist area m^2	Isovist area\ total area%	Sample (street)	Reference point (middle)	Isovist area m^2	Isovist area\ total area%
Tasku		22s.17	58%	Center district street		1165	88%
Djursan		29.02	19.73%	New district street		1590	84%
Tangzin		61.62	55.6%	South district street		2011	68.4%
Aoulad Bllel		58.34	60.28%	East district street		1330	63.8%

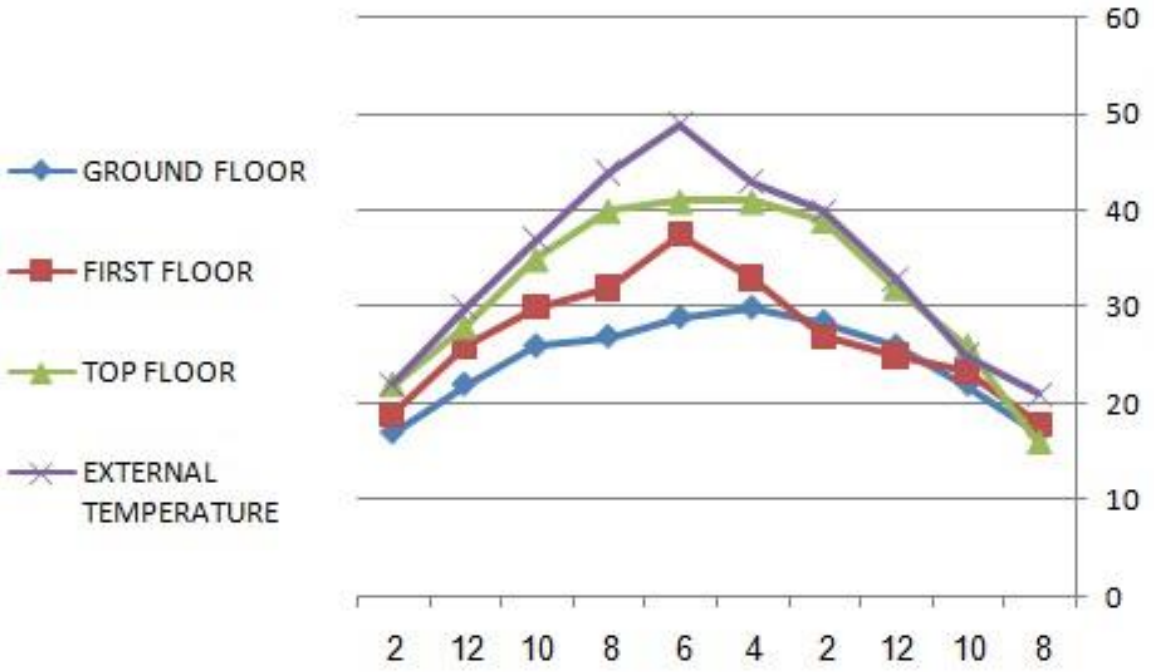
Isovist Measurements of Streets Samples



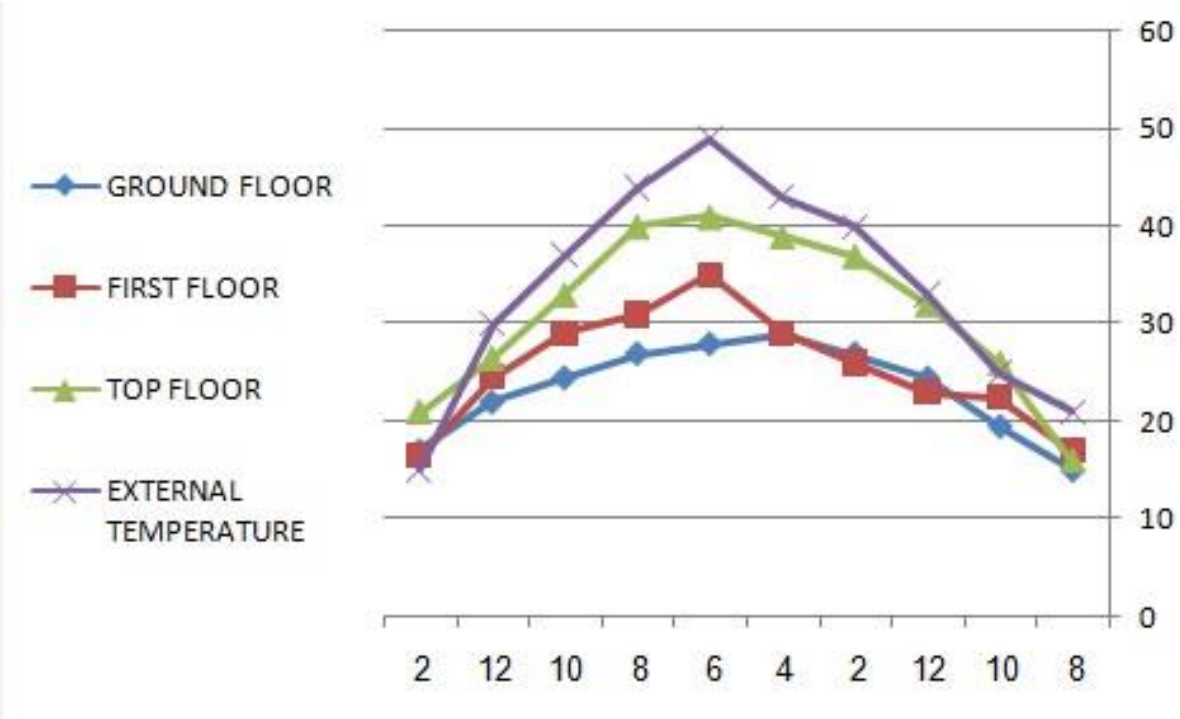
Isovist Measurements of Modern and Old Streets, (source, author).



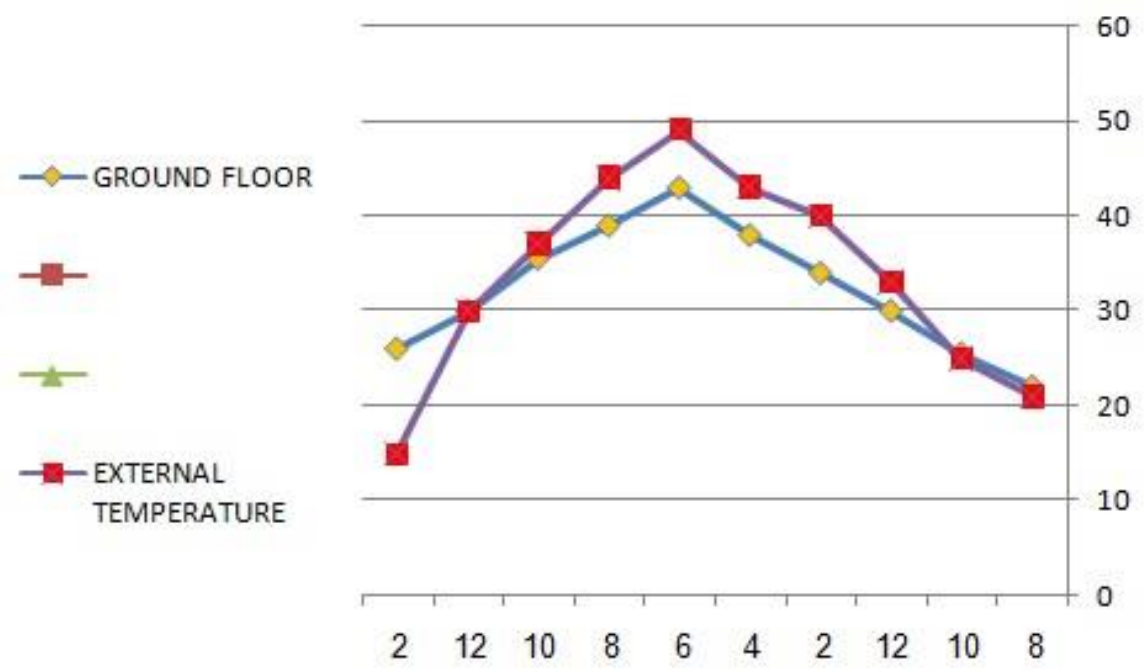
Indoor Temperature in Traditional House1, Sample1 (H1)



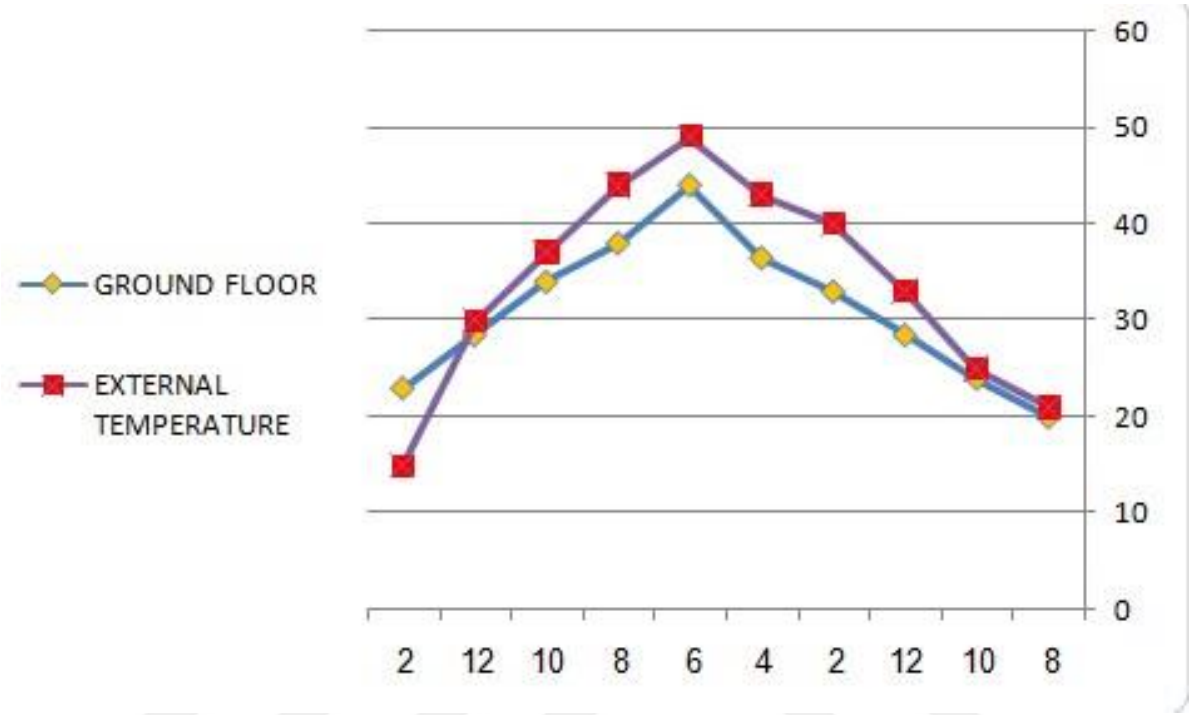
Indoor Temperature in Traditional House2, Sample2 (H2)



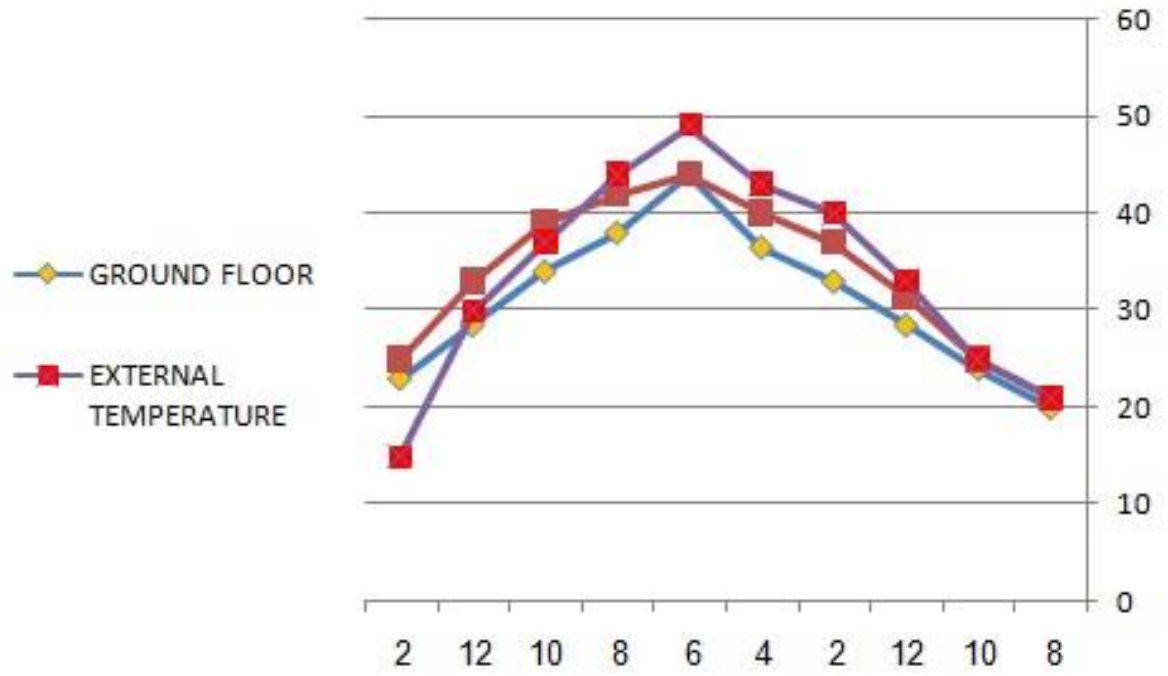
Indoor Temperature in Traditional House3, Sample3 (H3)



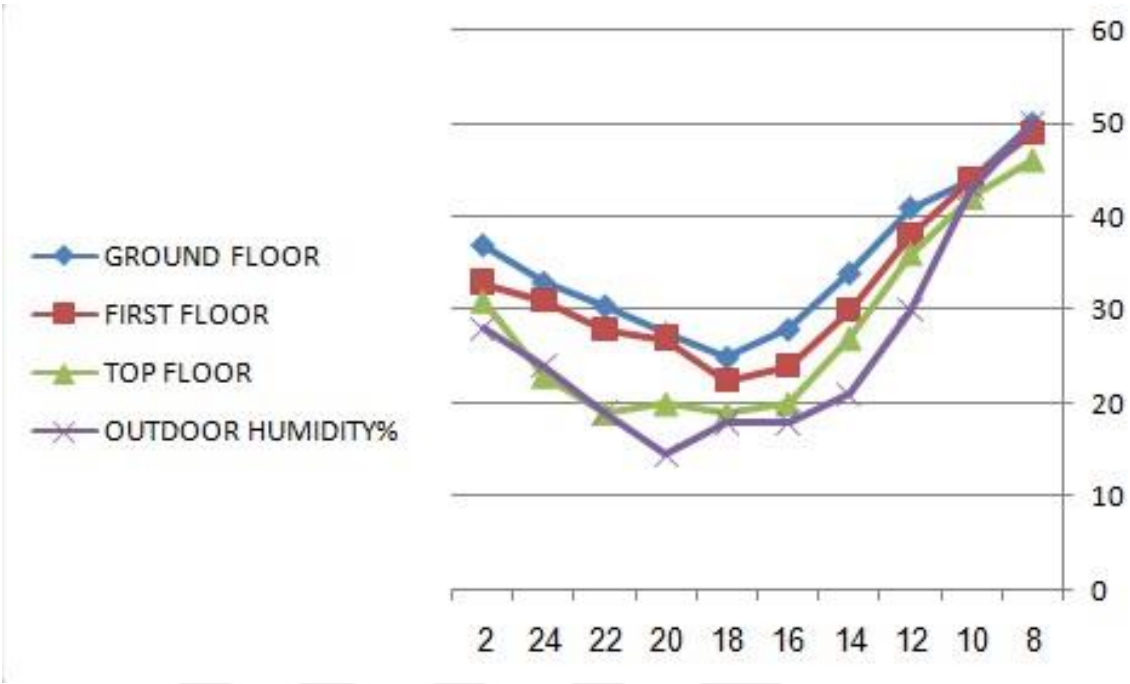
Indoor Temperature in Contemporary House1, Sample4 (H4)



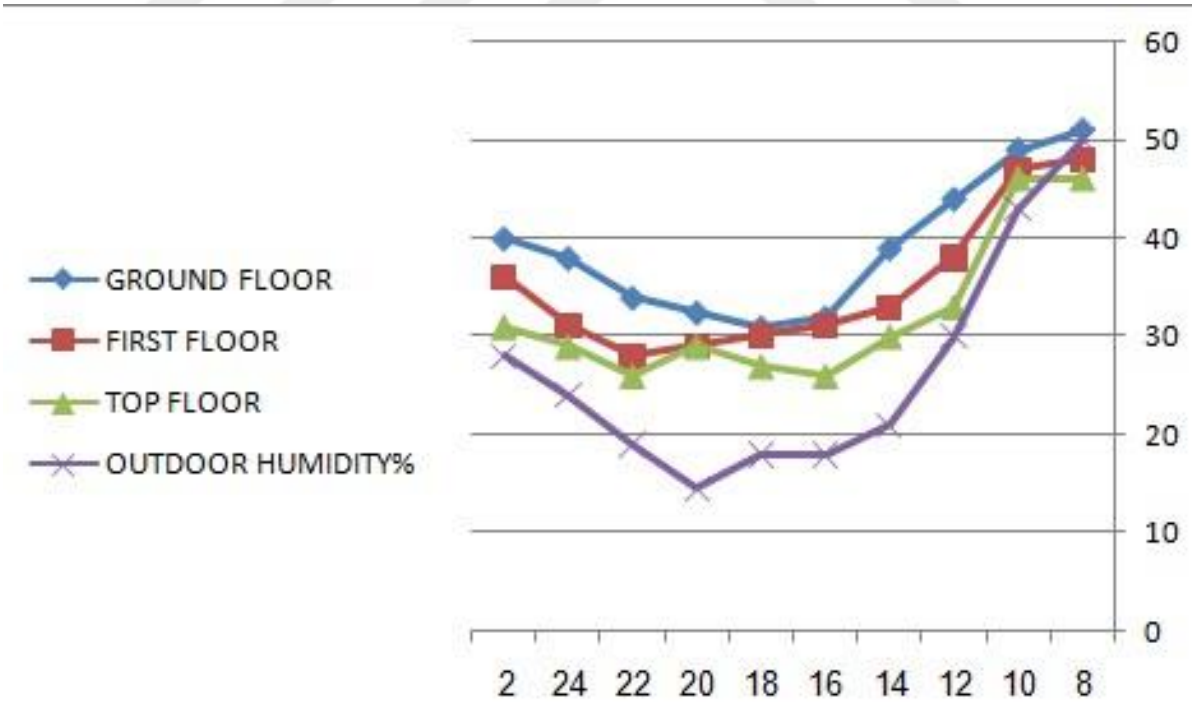
Indoor Temperature in Contemporary House2, Sample5 (H5)



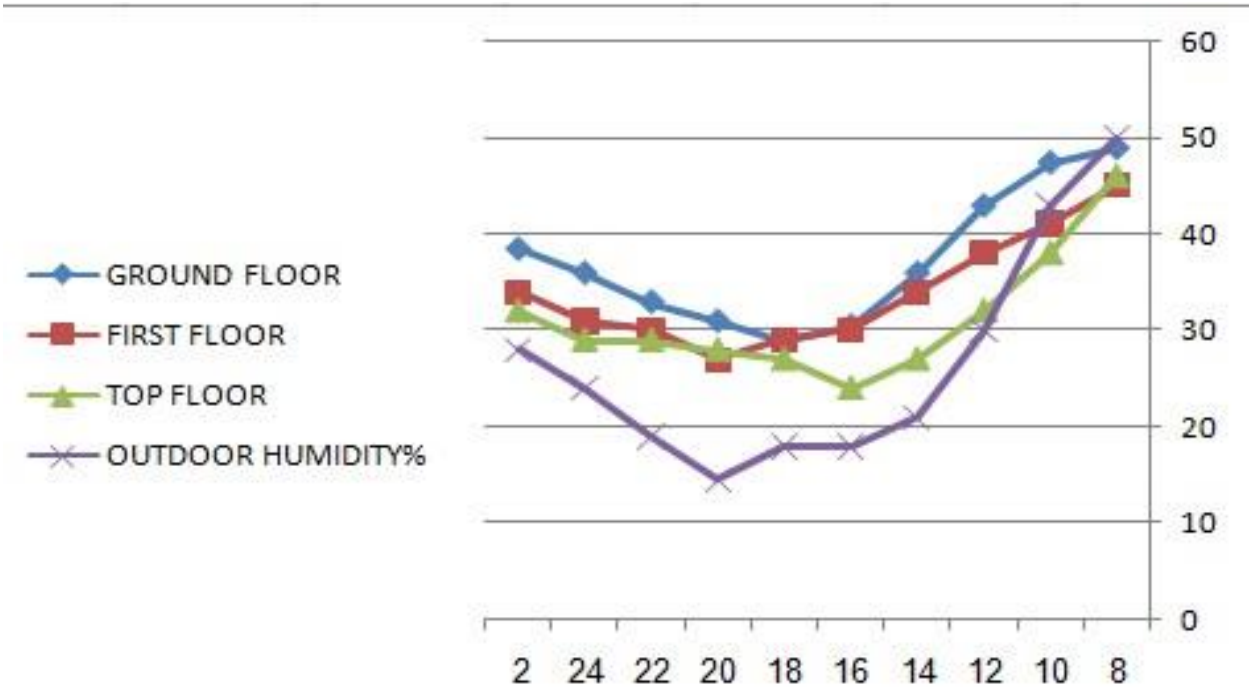
Indoor Temperature in Contemporary House3, Sample5 (H6)



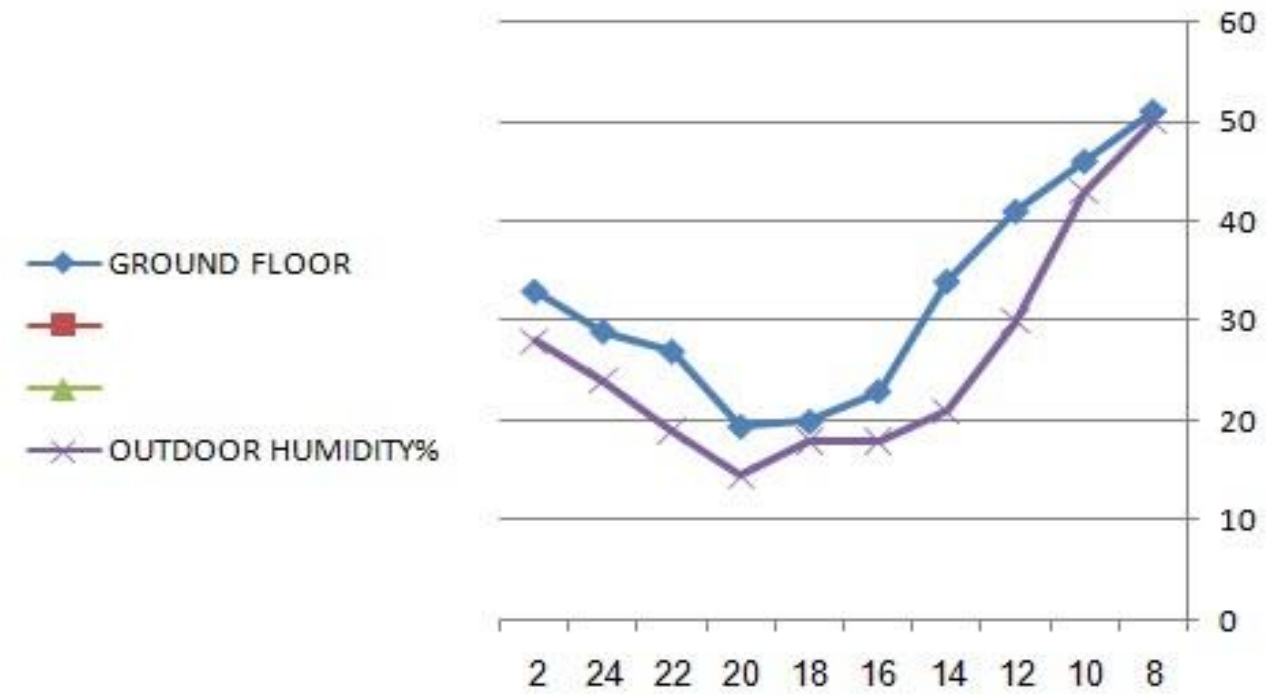
Indoor Relative Humidity in Traditional House1, Sample1 (H1)

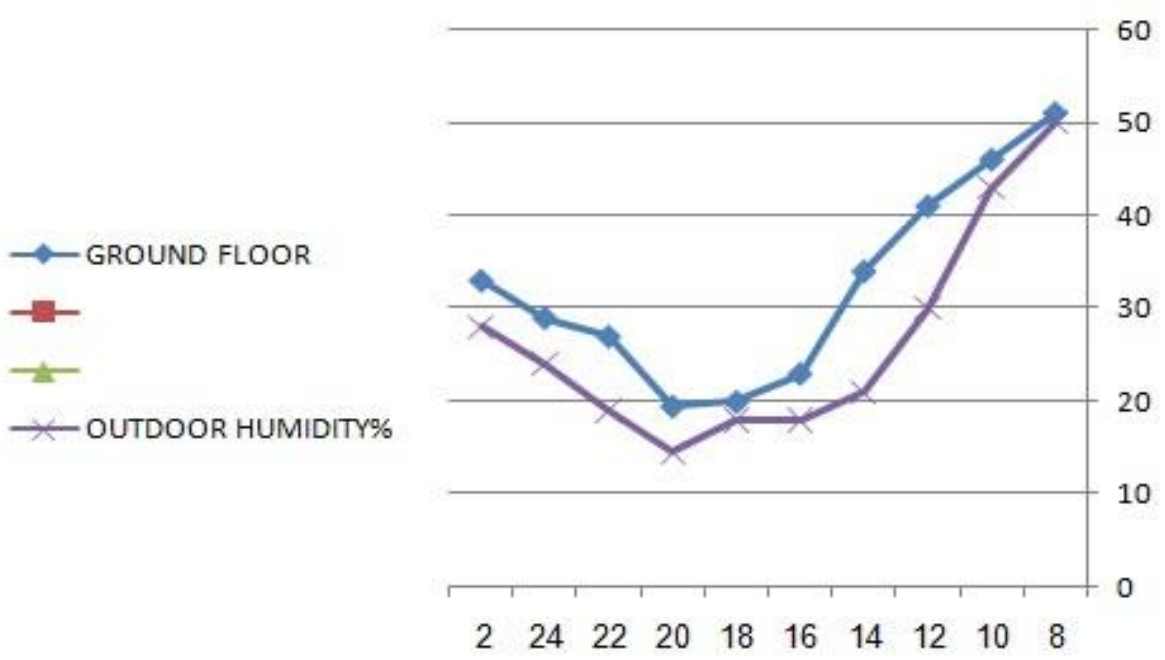


Indoor Relative Humidity in Traditional House2, Sample2 (H2)

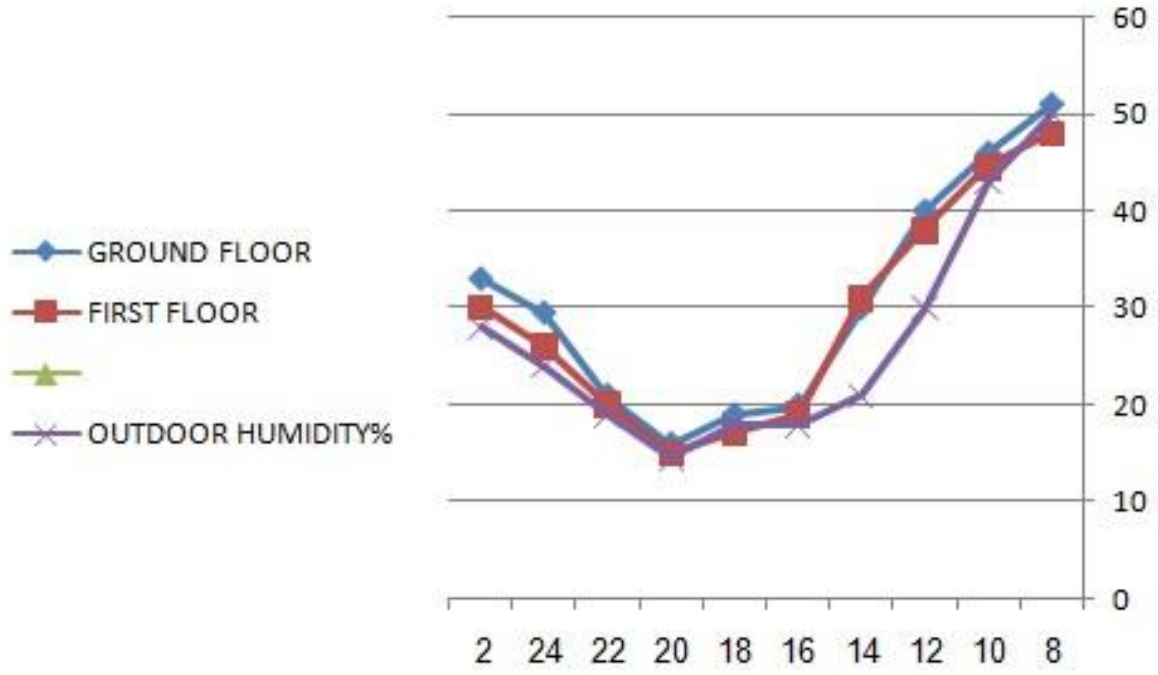


Indoor Relative Humidity in Contemporary House1, Sample4 (H4)

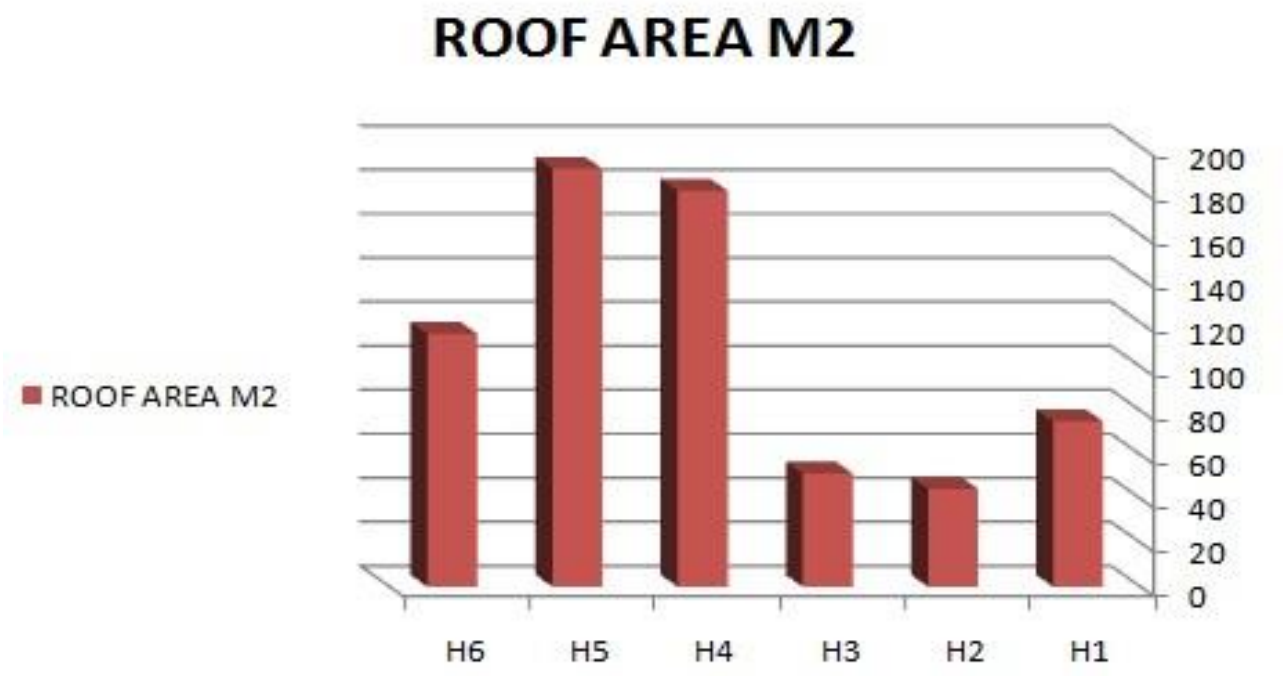




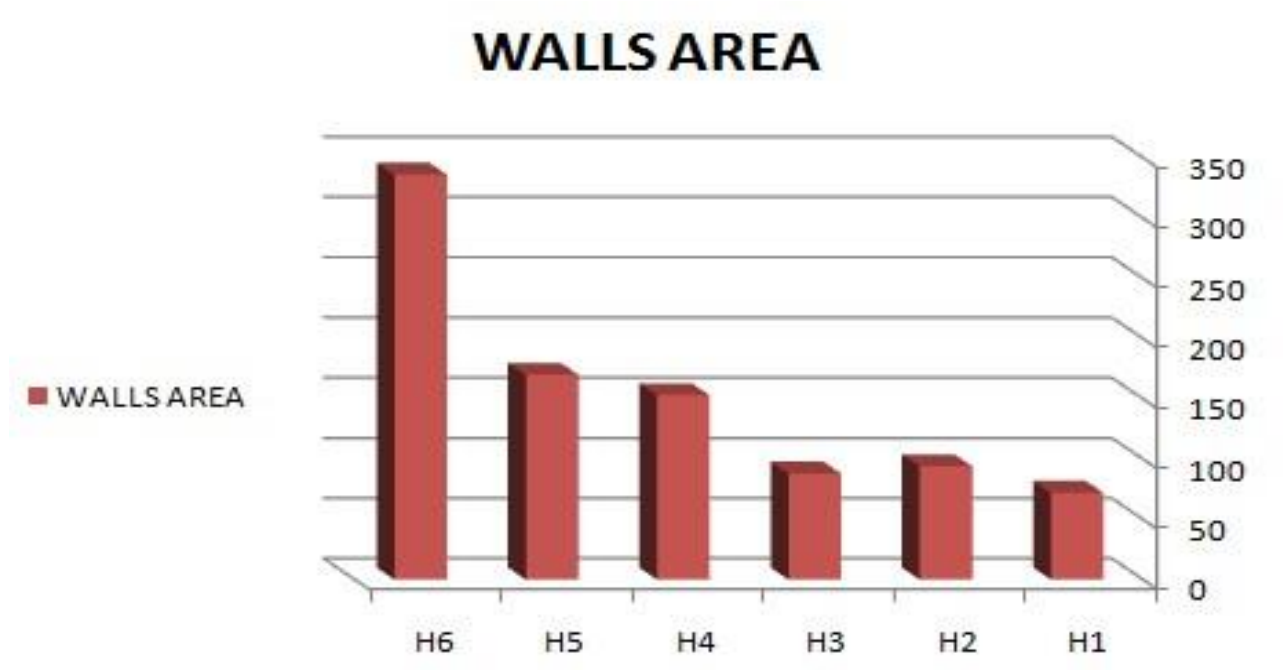
Indoor Relative Humidity in Contemporary House2, Sample5 (H5)



Indoor Relative Humidity in Contemporary House3, Sample6 (H6)



Exposure Area of Roofs



Exposure Area of Walls

APPENDIX C: QUESTIONNAIRE

QUESTIONNAIRE

Dear candidate, this questionnaire is prepared to investigate an architectural study of Ghadames houses and the impact of transformation from traditionalism to modernism on Ghadames houses. Therefore, researcher would like to answer the following questions according to your opinion.

Put a sign on the chosen answer

Candidate data:-

Name:-

Age:-

Occupation:-

Group1 traditional houses and settlement

Q1- Traditional houses of Ghadames were built by natural local materials

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q2- Traditional houses in Ghadames are being considered as the main source of local architecture style.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q3- there is no harmony between traditional houses (color. Size, texture, facades).

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q4- Traditional houses of Ghadames are having architectural features such as visual privacy and thermal comfort.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q5- occupant of traditional settlement of Ghadames had been depending on electrical means (such as air conditioners and fans) to provides thermal comfort.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q6- Traditional house of Ghadames was built to be visually exposed from outside to inside.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q7- modern concrete houses are built to provide thermal comfort without using electrical and mechanical means.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q8- in contemporary neighborhood, females (women and girls) are allowed to walk together with males (men and boys).

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q9- contemporary houses were built by mud and wood.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q10- in modern house, the access to the core of traditional houses is easy and direct.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q11- the architectural style of modern buildings is similar to traditional houses architecture.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Group2 society

Q12- mixing between genders is acceptable in traditional society of Ghadames.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q13- during social activities, women and men are being separated.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q14-climate is an important determinant of daily activities of Ghadames family.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q15- modern houses with external courtyards are more private than closed traditional houses.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q16- the family in modern houses could do activities and spend time in external courtyard.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q17- Ghadames society is a :-

a- Tribal. B-familial. C-mixed

Q18- family is the social nucleus of Ghadames society in both traditional and modern society.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q19- gender segregation in Ghadames society is:-

a- Religious teachings. B- traditions. C- both.

Q20- modern society is more connected than traditional society.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Group 3 daily lifestyle

Q21- in traditional settlement, family members spend most of their time outside the house.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q22- men share women raising kids and cocking in traditional family lifestyle.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q23- in traditional houses family spend most of the day in the living space (first floor).

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q24- modern houses contain spaces for living.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q25- modernity affected daily lifestyle, where it is different from traditional lifestyle.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q26- men in vernacular settlement had been working in agriculture, building, trading, and literal industries. Which is similar to nowadays lifestyle.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q27- in modern society, women go to work, what are the main sectors that women work in?

Q28- women spend their time in:-

a- Home. b- work. c- equally.

Q29- harsh climate impacts directly on the daily lifestyle in both traditional and modern society.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Thank you for contribution.

Signature:-

4- QUESTIONNAIRE

Dear candidate, this questionnaire is prepared to investigate an architectural study of Ghadames houses and the impact of transformation from traditionalism to modernism on Ghadames houses. Therefore, researcher would like to answer the following questions according to your opinion.

Put a sign on the chosen answer

Candidate data:-

Name:-

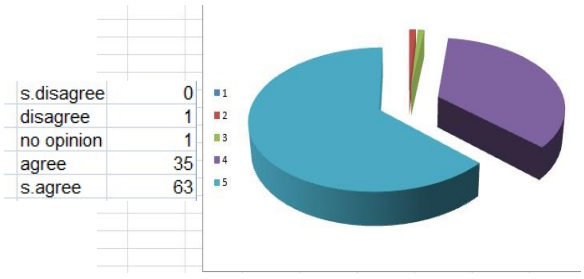
Age:-

Occupation:-

4-1- Group1 the architectural features of traditional houses and contemporary houses

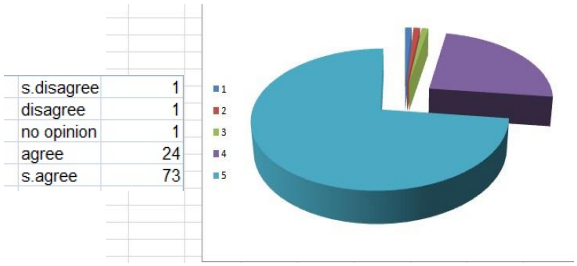
Q1- Traditional houses of Ghadames were built by natural local materials

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



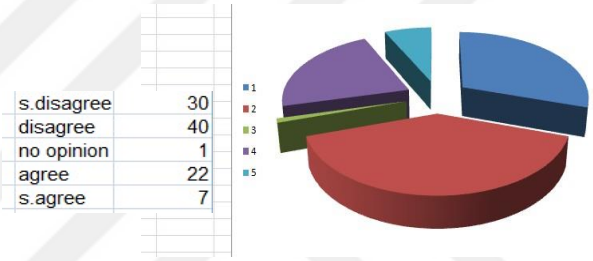
Q2- Traditional houses in Ghadames are being considered as the main source of local architecture style.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



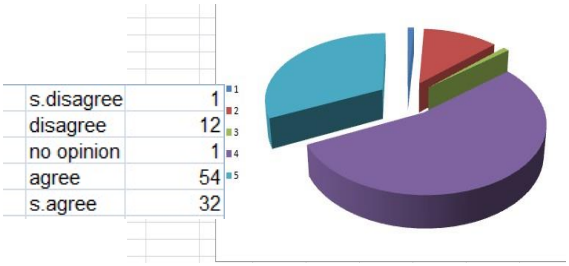
Q3- there is no harmony between traditional houses (color. Size, texture, facades).

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



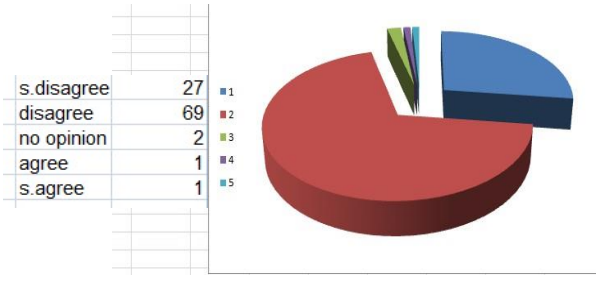
Q4- Traditional houses of Ghadames are having architectural features such as visual privacy and thermal comfort.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



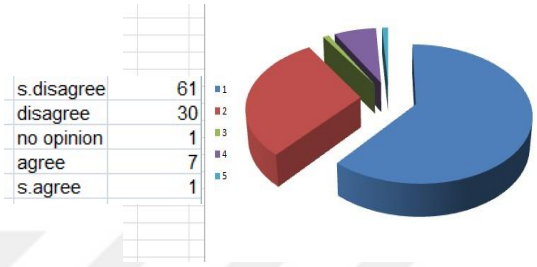
Q5- occupant of traditional settlement of Ghadames had been depending on electrical means (such as air conditioners and fans) to provides thermal comfort.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



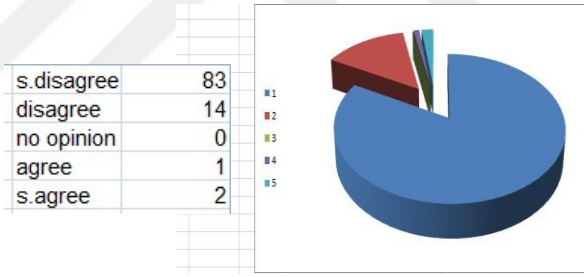
Q6- Traditional house of Ghadames was built to be visually exposed from outside to inside.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



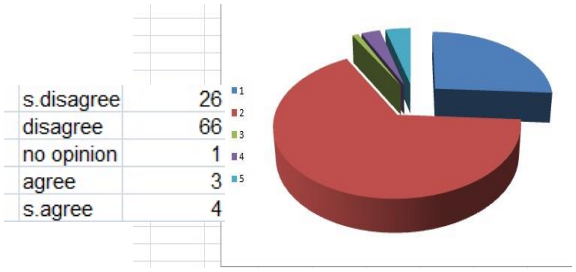
Q7- modern concrete houses are built to provide thermal comfort without using electrical and mechanical means.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



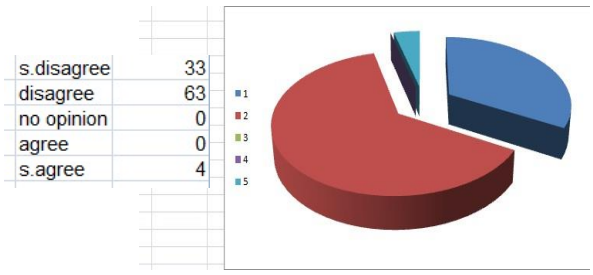
Q8- in contemporary neighborhood, females (women and girls) are allowed to walk together with males (men and boys).

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



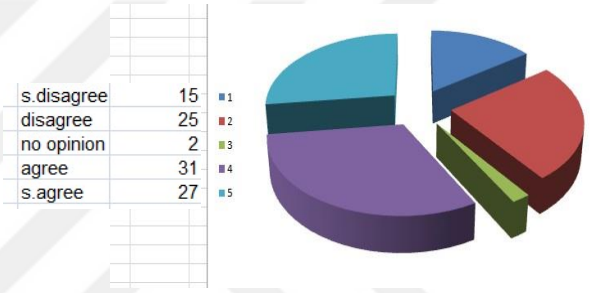
Q9- contemporary houses were built by mud and wood.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



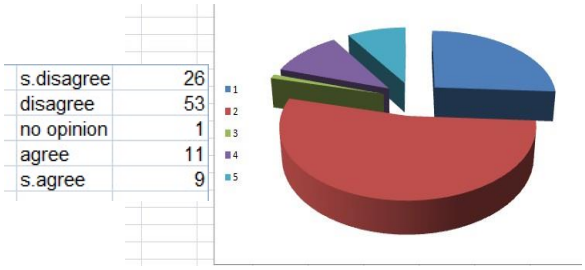
Q10- in modern house, the access to the core of houses is more difficult and longer than accessibility in vernacular houses.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



Q11- the architectural style of modern buildings is similar to traditional houses architecture.

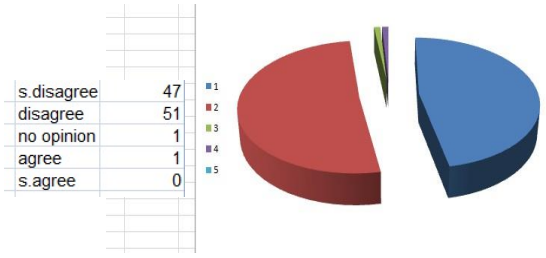
Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



4-2- Group2 society

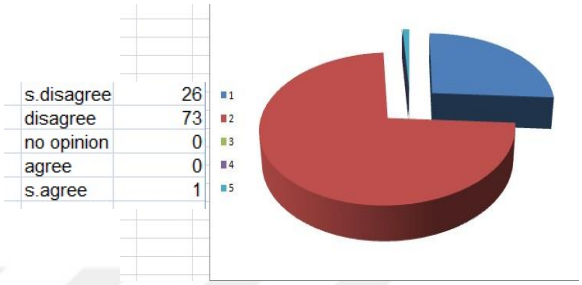
Q12- mixing between genders is acceptable in traditional society of Ghadames.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



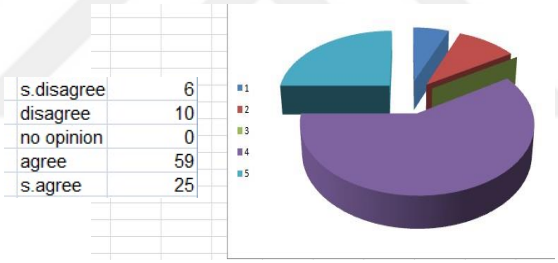
Q13- during social activities, women and men are being separated.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



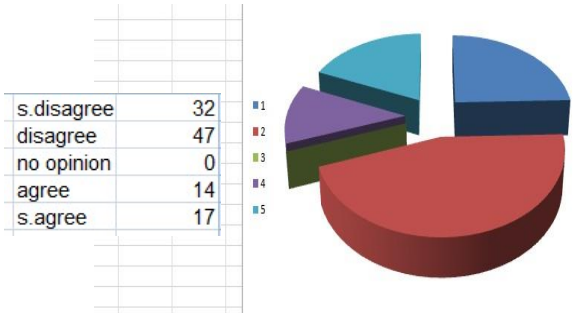
Q14-climate is an important determinant of daily activities of Ghadames family.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



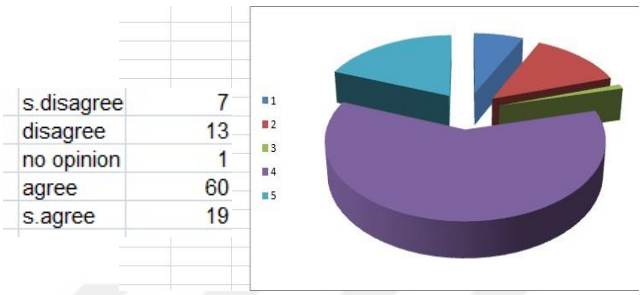
Q15- modern houses with external courtyards are more private than closed traditional houses.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



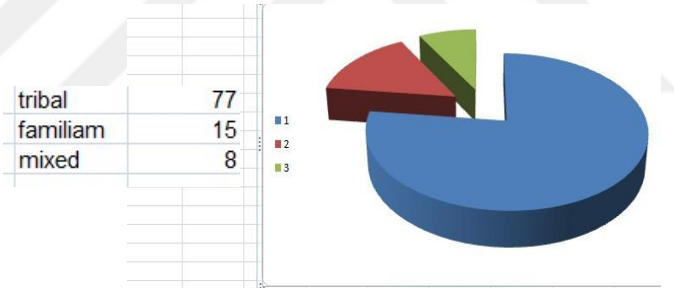
Q16- the family in modern houses could do activities and spend time in external courtyard.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



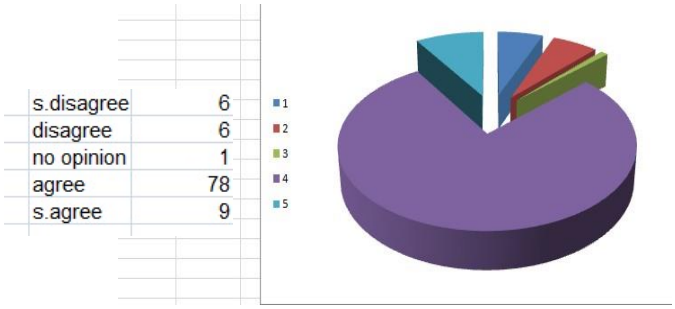
Q17- Ghadames society is a :-

b- Tribal. B-familial. C-mixed



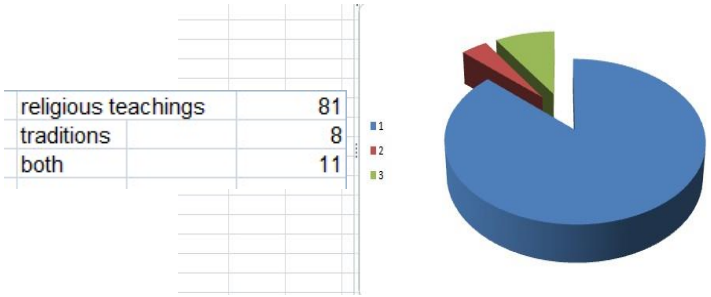
Q18- family is the social nucleus of Ghadames society in both traditional and modern society.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



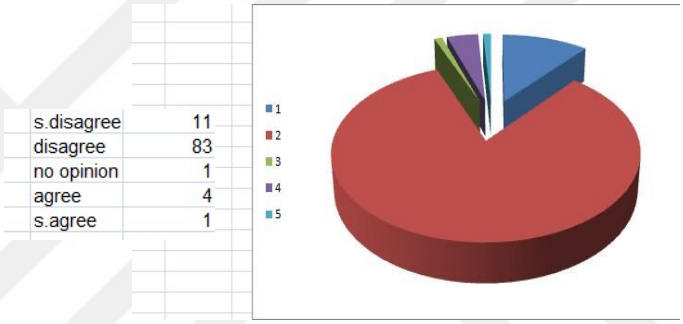
Q19- gender segregation in Ghadames society is:-

b- Religious teachings. B- traditions. C- both.



Q20- modern society is more connected than traditional society.

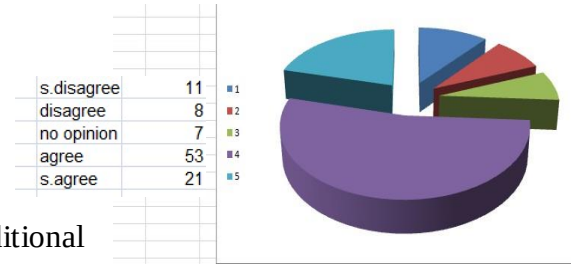
Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



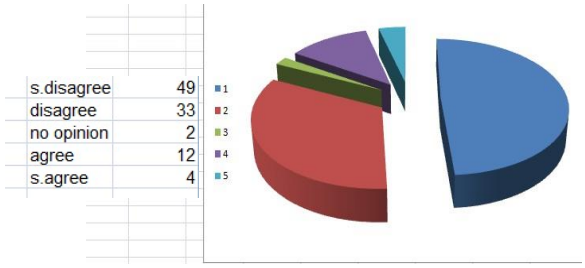
4-3- Group 3 daily lifestyle (the relation between individual and space)

Q21- in traditional settlement, family members spend most of their day time outside the house.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

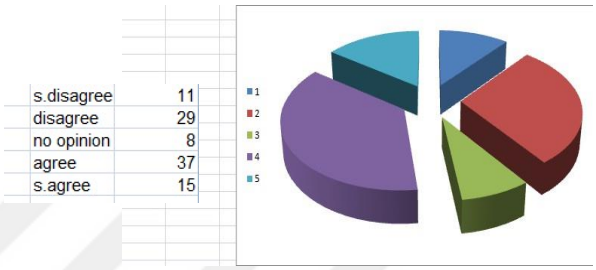
Q22- men share  women raising kids and cocking in traditional family lifestyle.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



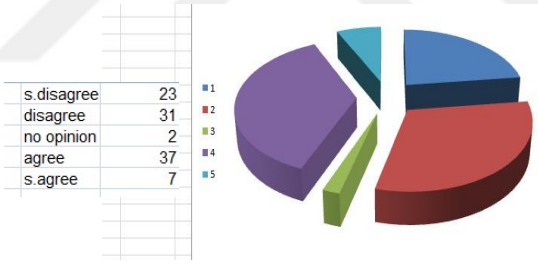
Q23- in traditional houses family spend most of the day in the living space (first floor).

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



Q24- modern houses contain spaces for living.

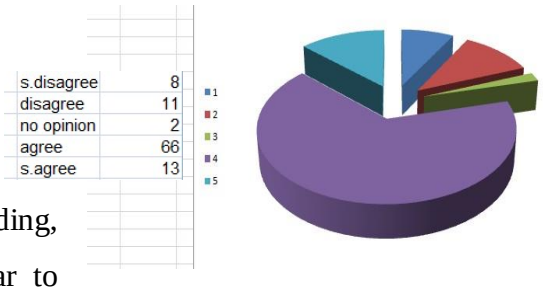
Strongly agree. Agree. No opinion. Disagree. Strongly disagree.



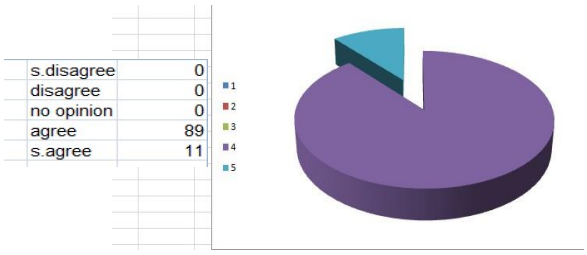
Q25- modernity affected daily lifestyle, where it is different from traditional lifestyle.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Q26- men in vernacular settlement had been working in agriculture, building, trading, and literal industries. Which is similar to nowadays lifestyle.



Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

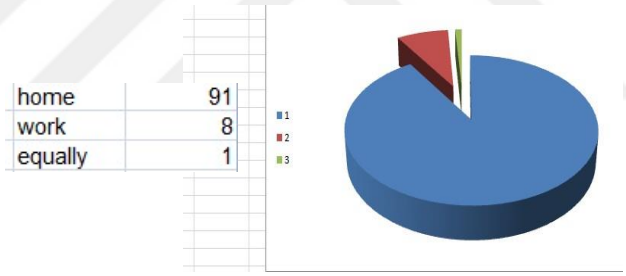


Q27- in modern society, women go to work, what are the main sectors that women work in?

Education and health care (taken from in-depth interview).

Q28- women spend most of their time in:-

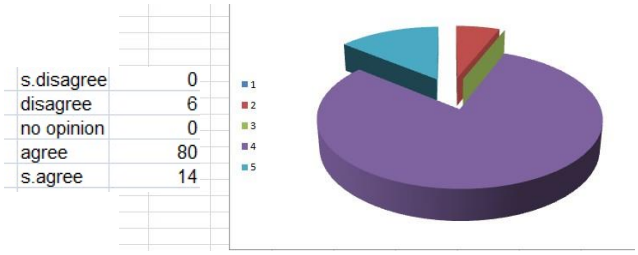
b- Home. B- work. C- equally.



Q29- harsh climate impacts directly on the daily lifestyle in both traditional and modern society.

Strongly agree. Agree. No opinion. Disagree. Strongly disagree.

Summary of the questionnaire:-



According to the previous data, questionnaire results could present the satisfaction levels of privacy, thermal performance and architectural properties (design, colors, and façades) as follows:-

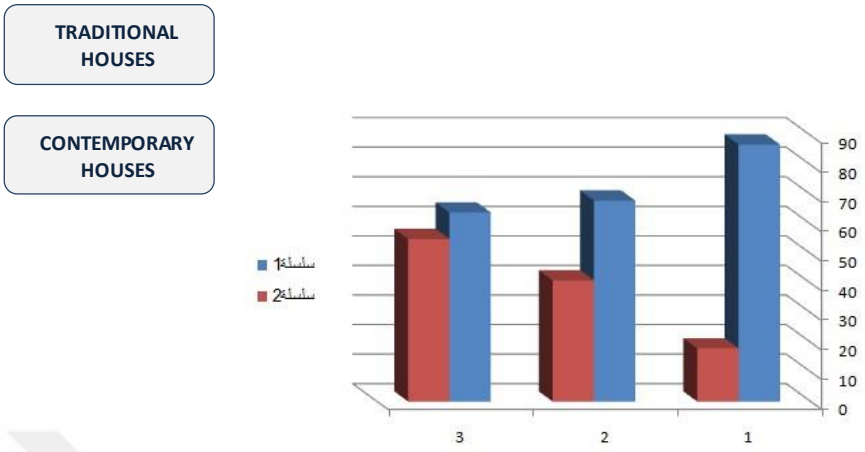


Figure (39) satisfaction levels graph.

Each column shows comparatively their actions on traditional and contemporary houses. Column1 presents thermal performance satisfaction, while column2 shows privacy satisfaction and column3 presents architectural properties. It is obvious that there is a big differences between traditional and modern houses in both of thermal performance and privacy, while, it is almost same for the architectural features.

Why there are big differences in thermal performance and privacy?

To find out the answer, further methods would be done to investigate (why).

5- IN-DEPTH INTERVIEW

Researcher had prepared an in-depth interviews with managers (administrators),

elders owners, designers and builders (contractors) with samples of (16 designers, 3administrators, and 4 elders), to investigate about the similarities and differences between traditional houses and modern houses.

Dear candidate, the given information would be used in a PhD research.

Sample1, elders and users of both traditional and contemporary settlement.

Candidate data:

Name:

Age:

Profession:

Q1- would you please explain the architectural features of traditional house in terms of:

a. construction materials

b. construction methods

c. spatial organization

d. thermal performance and climate.

e. settlement planning, streets, neighbors contents, and built environment.

f. lifestyle and social interaction.

g. privacy and visual privacy

Q2- would you please explain the architectural features of modern house in terms of:

a. construction materials

b. construction methods

c. spatial organization

d. thermal performance and climate.

e. settlement planning, streets, neighbors contents, and built environment.

f. lifestyle and social interaction.

g. privacy and visual privacy

if there are similarities or differences between vernacular dwellings, would you please name them?

Q3- would you please give your opinion about the socio-cultural values in old society and whether they are exist in present days or not, if not would you please explain why?

Q4- would you please explain how old houses behave in hot summers and what treatments that had been used to provide thermal comfort in both summer and winter?

Q5- would you please explain the importance of both gender segregation and visual privacy and how they affected spatial arrangement of old houses?

Sample1, elders and users of both traditional and contemporary settlement.

Candidate data:

Name:

Age:

Profession:

Q1- would you please explain the architectural features of traditional house in terms of:

a. construction materials

b. construction methods

c. spatial organization

d. thermal performance and climate.

e. settlement planning, streets, neighbors contents, and built environment.

f. lifestyle and social interaction.

g. privacy and visual privacy

Q2- would you please explain the architectural features of modern house in terms of:

a. construction materials

b. construction methods

c. spatial organization

d. thermal performance and climate.

e. settlement planning, streets, neighbors contents, and built environment.

f. lifestyle and social interaction.

g. privacy and visual privacy

if there are similarities or differences between vernacular dwellings, would you please name them?

Q3- would you please give your opinion about the socio-cultural values in old society and whether they are exist in present days or not, if not would you please explain why?

Q4- would you please explain how old houses behave in hot summers and what treatments that had been used to provide thermal comfort in both summer and winter?

Q5- would you please explain the relationship between type of building materials and thermal performance of the dwellings?

Q6- would you please explain your point of view about thermal performance, if mechanical and electrical means were ignored, which houses are better, traditional buildings or contemporary buildings?

Q8- would you please explain whether spatial organization of traditional and contemporary house is same or not, if not, why?

Q9- would you please explain the importance of both gender segregation and visual privacy and how they affected spatial arrangement of old houses?

Q10- what are aspects of change between old and modern dwellings?

Q11- how modernity influenced desert house design, negatively or positively, why?

VITA